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AUGUST, 1941

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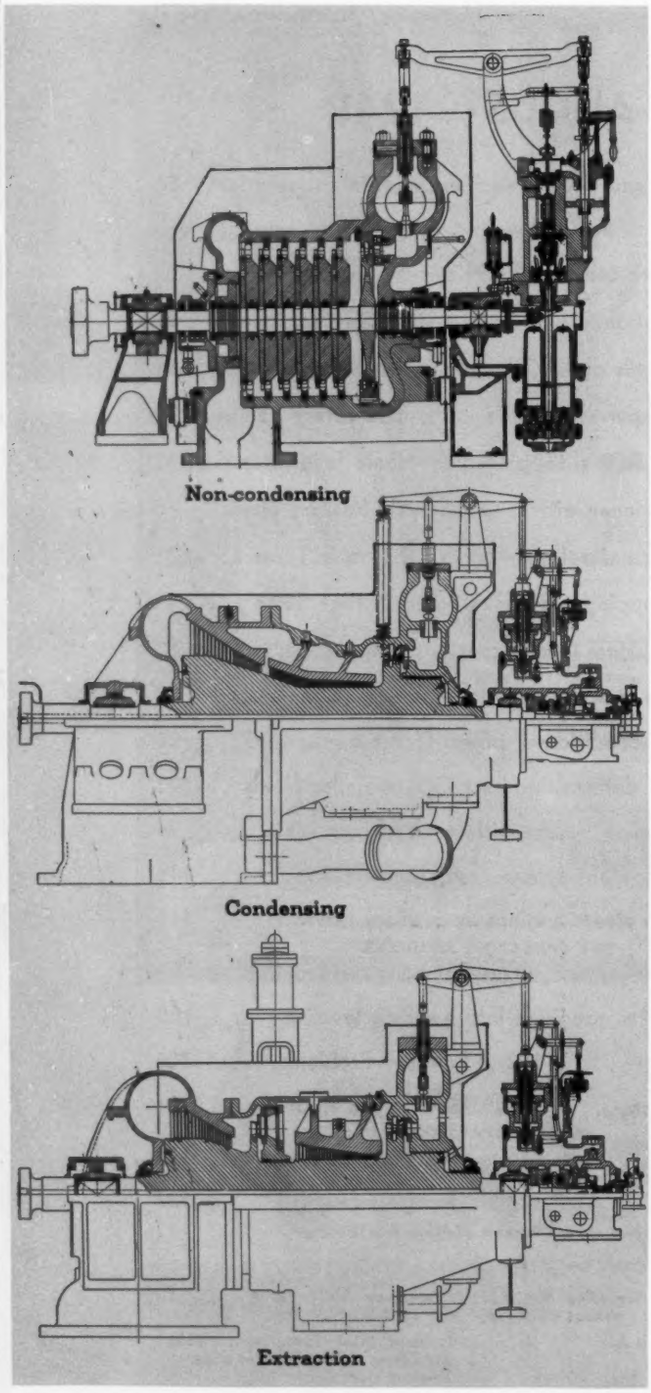
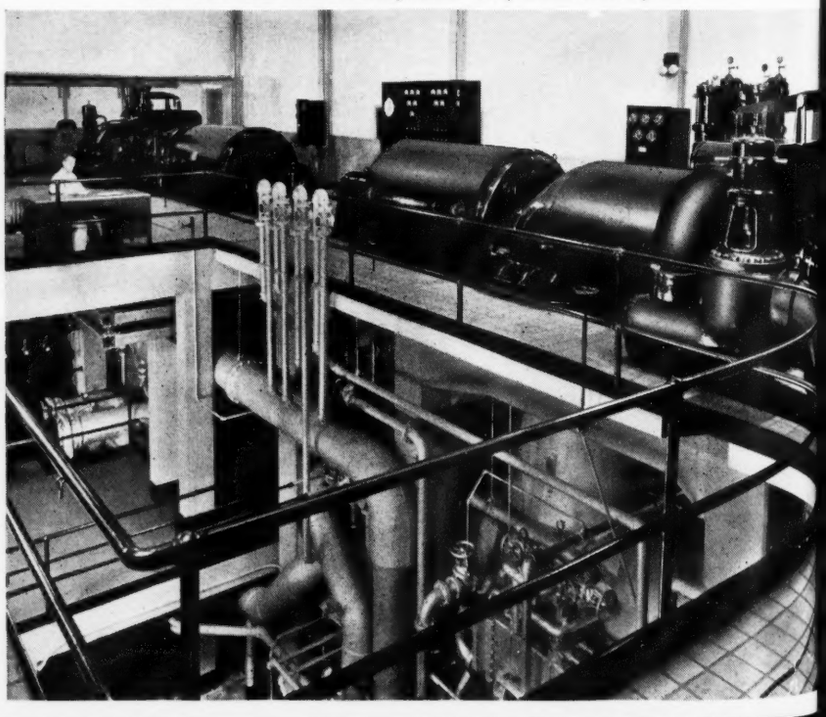


World's Largest Turbines and Steam Auxiliaries Are Well within the Scope of Westinghouse Experience and Manufacturing Facilities

Westinghouse design and manufacturing experience includes turbine-generators and steam auxiliaries up to the largest, with applications covering an almost unlimited variety of steam conditions, use of process steam and electric power requirements. You may never need a turbine that will rate as a "world's largest" —but you *can* benefit from the experience and manufacturing standards which lead turbine buyers to Westinghouse when the requirements are unusually exacting.

This is an important advantage in turbines down to 5 hp—and it grows more important in larger sizes or in those applications where special conditions must be met.

These two 4000 kw extraction turbine-generators, with condensers, supply electric power and process steam for the New York and Pennsylvania Co., Lock Haven, Pa.



Westinghouse

POWER

Established 1882 • PHILIP W SWAIN, Editor

What About Power Shortage?

GOVERNMENT REPRESENTATIVES PREDICT a power shortage; utility interests believe power supply is ample. Both can't be right—or can they? The answer is that both may be right, but that each means a different thing by the simple words "power shortage".

Engineers for private utilities have always considered power shortage as a failure to meet *existing demands* or demands that might be reasonably expected to materialize in the near future. On this basis, there are no present shortages except in the Southeast, where drought and unprecedented power demands for aluminum have hit systems top-heavy with hydro. Likewise, on this basis, present plans for capacity expansion are adequate for any load growth that may reasonably be expected in the next few years.

But, and it is a big "but", government representatives put the matter this way: "We must equal German production of armaments, now estimated of the rate of 45 billions per year (American equivalent). This means jacking up present production for defense by more than 300%. If this is done in the next two years, power requirements will far outstrip present plans for capacity expansion. We *must* and *will* expand defense production at this rate, *or at a higher* rate, and thus *there is bound to be a power shortage*".

One might reasonably ask how it is physically possible for defense production to increase so much without cutting greatly into civilian production and thereby releasing much of the power needed for the new defense production. And it would be fair to ask whether available manhours, materials and transportation facilities will not necessarily limit power loads to amounts easily handled by the projected new power capacity.

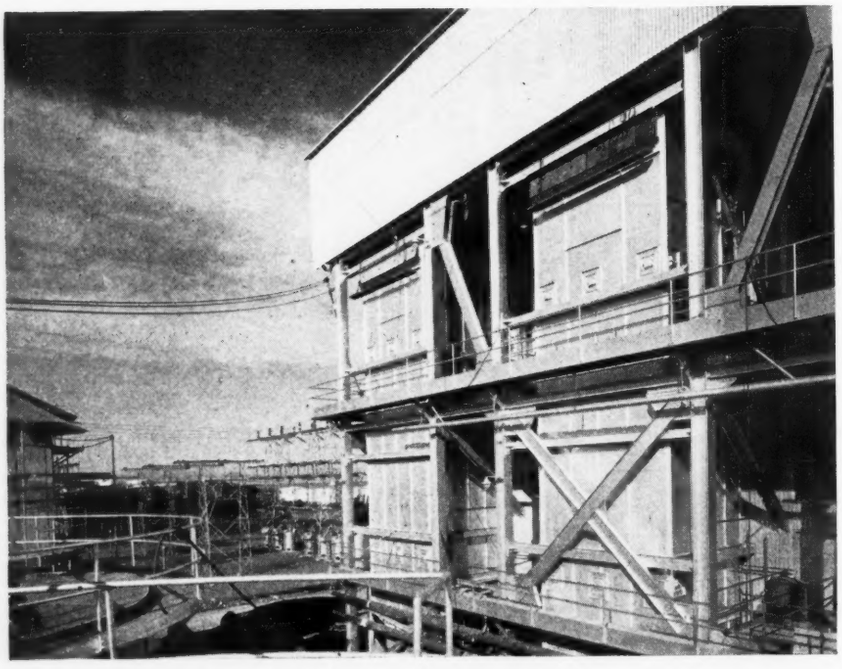
Such questions are fully justified from the angles of engineering and peace-time economics. They must *not* be so stressed as to hide another great fact—that the government's present philosophy of impending power shortage is a ruling conviction that will certainly guide public action and must therefore, right or wrong, be considered in the plans of practical men in industry.

Acceptance of this philosophy as a working basis means (1) ordering all equipment that can be installed within reason whether or not there seems to be specific use for it, (2) helping industrial customers eliminate power waste, improve power factor and utilize off-peak capacity, (3) planning curtailment of non-essential power uses.

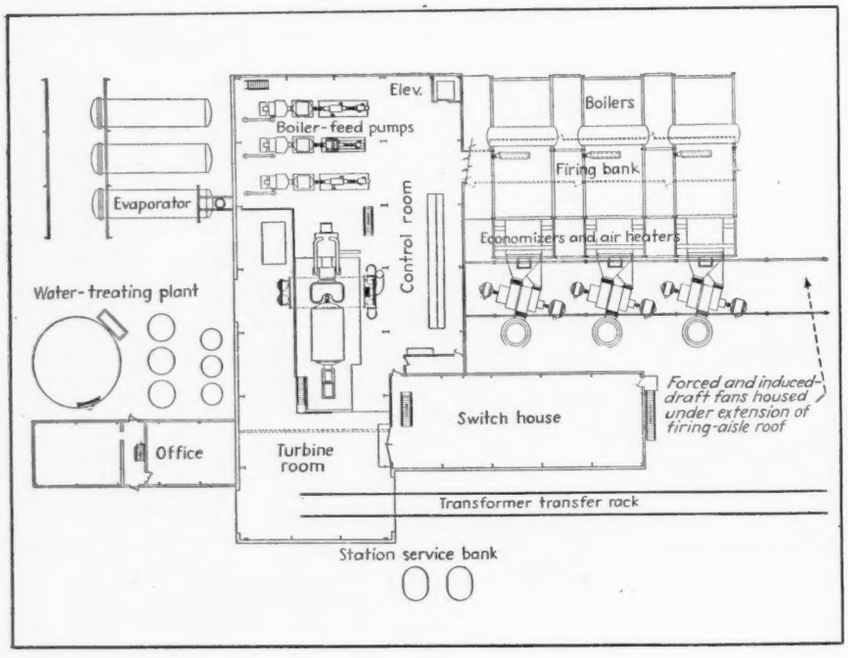
Such actions will be a practical recognition of the fact that even engineers sometimes guess the future wrong, so it's well to play safe when both reputation and national defense are at stake.

Avon, Martinez, Oleum—Achievement in

Pacific Gas & Electric builds three steam plants next to three oil refineries. Industrials get steam and power, supply refinery waste as fuel for central-station boilers; excess energy goes to defense-expanded West Coast. Two stations now operating, third starts this month



Avon, Martinez, Oleum—long heralded as the outstanding cooperative venture of the future—are now actualities. Avon (photo above showing outdoor boilers), serving Tidewater Associated Oil Co, has been operating since December 16, 1940; Martinez, supplying Shell Oil Co, went on the line in June; and the first unit at Oleum, generating for Union Oil Co, is scheduled for operation August 1, the second unit July 1, 1943. All three stations are on the shores of San Francisco Bay, adjacent to the respective oil refineries.



Back in 1938, the three oil companies signed identical contracts with Pacific Gas & Electric Co. Principal specifications were that the utility would supply steam and electricity for the refineries and in part payment would burn refinery wastes under its steam-generating units. Excess energy above industrial needs makes the stations valuable to the defense-expanded West Coast.

Estimated total requirements of the three refineries are: (1) 20,000 kw maximum demand, (2) approximately 120,000,000 kwhr per year, (3) electric power delivered at 2300 volts, 3 phase, (4) 875,000 lb steam per hr, maximum demand, and (5) 4 billion lb steam per year, delivered at 160 lb with 50 F superheat.

The three 40,000-kw stations, practically identical with minor exceptions, feature two distinct steam operating cycles, semi-outdoor earthquake-resistant construction, ability to burn multiple fuels either singly or in combination, and turbines with combined speed and automatic-extraction governing.

Equipment is arranged for most flexible operation and to take care of any future load growths. Turbines, switch house and control room are housed in a brick building. Boilers, evaporators, fans, water-softening equipment, condensers, contact and deaerating heaters are outdoors. The hot-air duct between air heaters and burner fronts forms a roof over the firing aisle; roofing over corresponding spaces between boilers encloses the aisle.

Design allows for future conditions. Should operations change so that steam would no longer be required, the plants could be operated full condensing. On the other hand, should more steam be required, additional boiler, turbine and evaporator capacity could be installed.

Cooperation

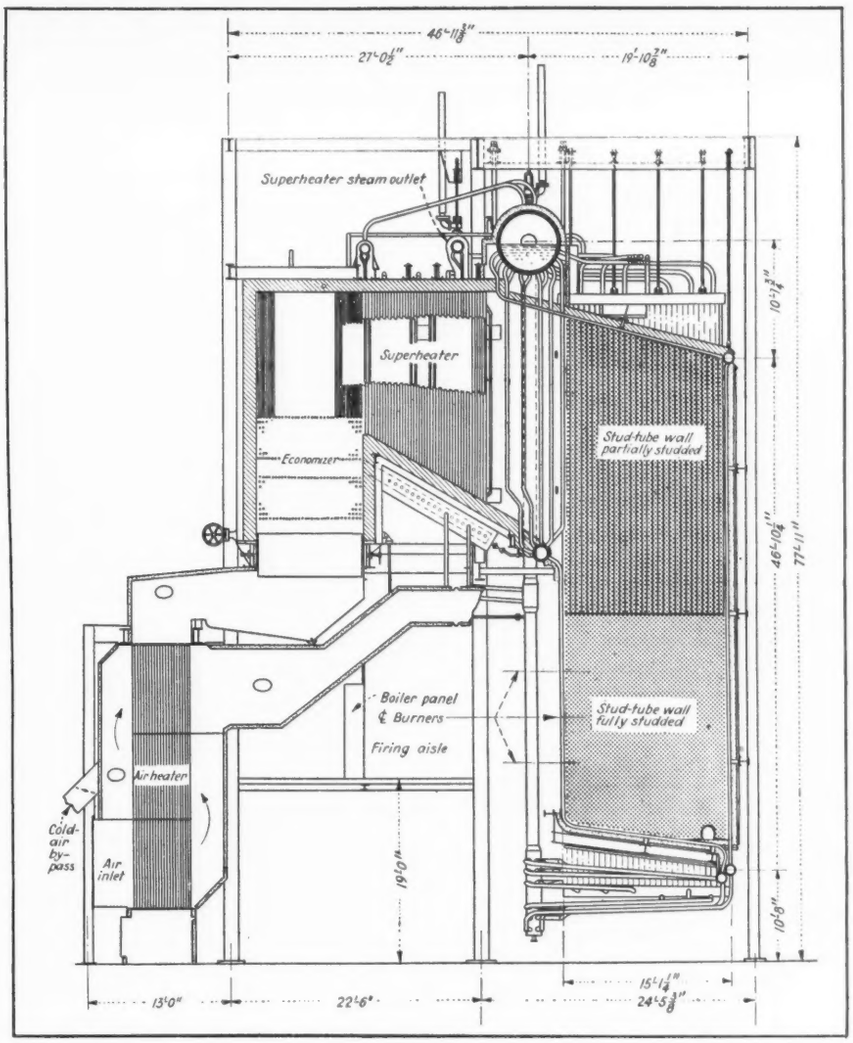
Boilers are B & W, 1525-lb, 950-F, 200,000-lb-per-hr radiant units. Avon and Martinez have three boilers; six are being installed at Oleum as recent load growth caused addition of a second 40,000-kw unit. 24-hour overload capacity of each steam-generating unit is 230,000 lb per hr. Under continuous operation efficiencies range from 81% with natural-gas firing to 88.3% with pulverized petroleum coke.

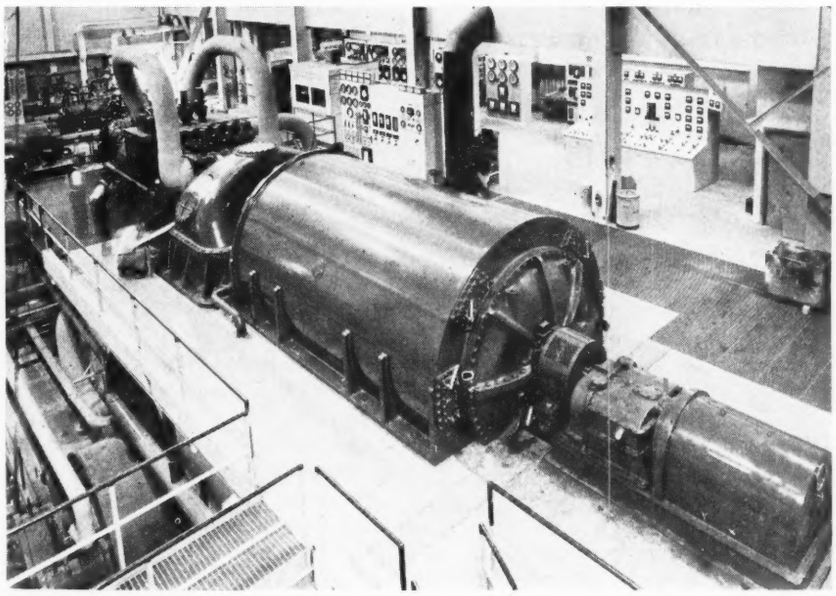
Pendant superheaters are designed to give 950 F at all loads above 100,000 lb per hr with gas fuel and above 150,000 lb with oil. Cyclone separators, along with steam scrubbers, assure steam of high quality and purity. Also, these permit wider fluctuations in water level without affecting steam quality and promote circulation by insuring steam-free water into downcomers.

Each furnace can be fired with natural gas, oil, acid sludge, pitch or pulverized petroleum coke through three combination burners arranged vertically, either singly or in combination. These fuels have so little ash that it was not necessary to provide for ash removal.

Economizers are conventional horizontal water-tubular units; gas flows down across the tubes, water enters at the bottom and flows up through the tubes. Tubular air heaters are back of and below the economizers.

A single combined forced- and induced-draft fan (Sturtevant) with both impellers on the same shaft serves each boiler. Each unit is driven by either of two motors mounted on opposite ends of the shaft. One is a 400-hp, 2400-volt, 3-phase, 900-rpm motor; the other is 1000 hp, 1200 rpm. Vane control varies quantities of air delivered from both forced and induced sides. The forced-draft fan has a maximum capacity of 67,500 cfm of 100-F air at 17.7 in. wg, the induced-draft fan delivers a maximum 134,000 cfm of 430-F gas at 25.6 in. wg.





Each 40,000-kw turbine is a tandem-compound General Electric unit with non-condensing, 3600-rpm turbine coupled to a single-flow, 3600-rpm condensing machine. The high-pressure section is designed for a maximum flow of 675,000 lb per hr; operating back-pressure is 225 lb. Under these conditions output is approximately 32,500 kw.

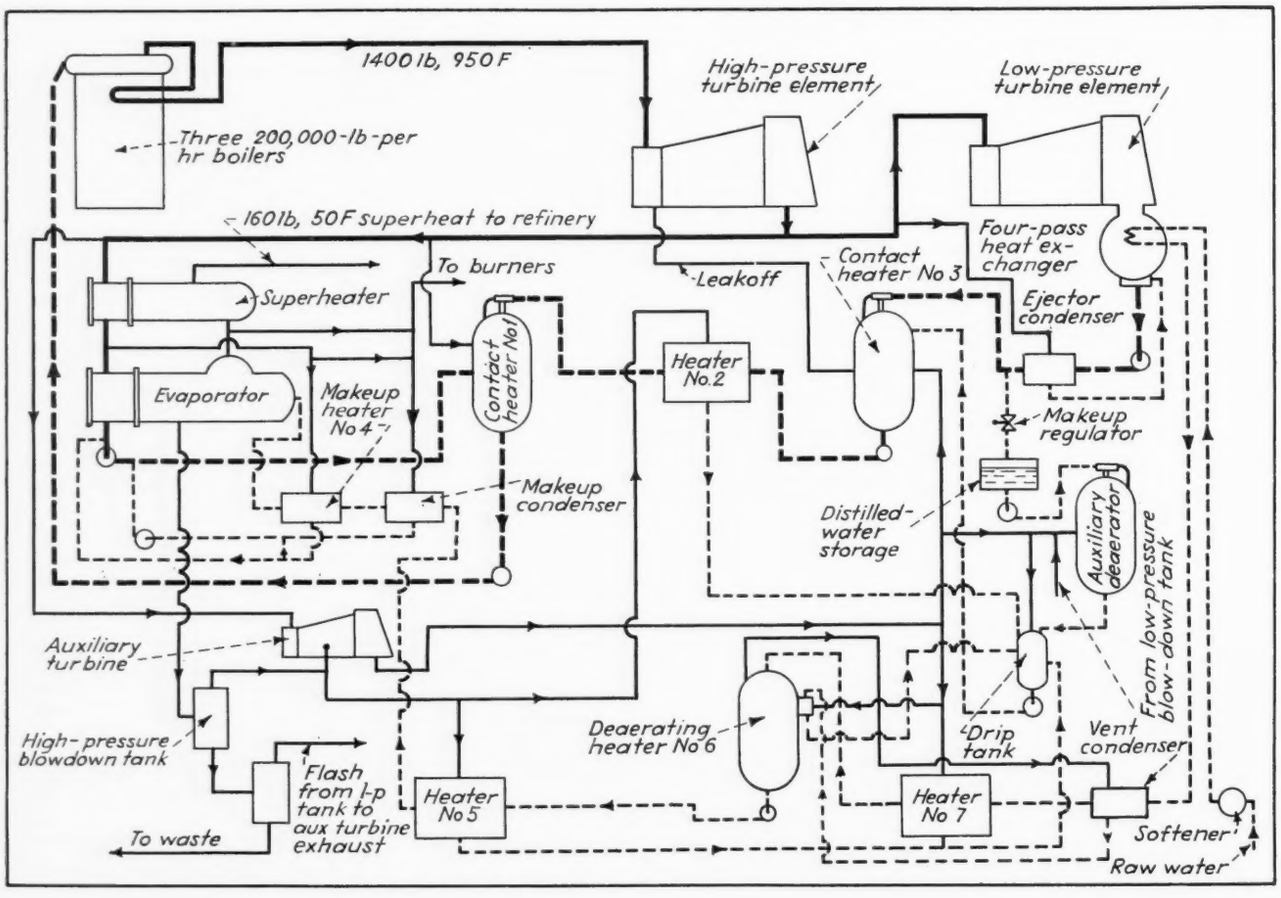
The low-pressure turbine is basically the manufacturer's standard 20,000-kw, 3600-rpm machine. The compound unit will carry something in excess of 50,000 kw under certain extraction and condensing conditions, when load demands require it.

Inlet ends of the two machines are on either side of the middle bearing pedestal; shafts are bolted together with forged couplings and the thrust bearing is between the two units. Main exhaust

of the high-pressure turbine is downward; the two auxiliary pipes leading into the inlets of the low-pressure machine are from the upper half of the casing, over the top of the high-pressure unit down into either side of the low-pressure nozzle chest. This simplifies the unit and foundation, provides for piping expansion and results in less exhaust loss in the high-pressure units.

Through a combination of speed and automatic extraction governing, operation of the turbines has been worked out to permit controlling the low- and high-pressure units as though they were separate machines. The main control valve on the high-pressure section is actuated largely by exhaust pressure; the backpressure governor is automatically reset by evaporator exhaust to maintain nearly constant 180 lb steam pressure.

Should load requirements be below output of the high-pressure section, its control valves are closed the necessary amount. The low-pressure-unit governor is arranged to permit holding these control valves open just enough to supply cooling steam to the low-pressure machine.



The flow diagram shows that there are actually two separate steam cycles: (1) electric-energy-generating cycle, in which steam is delivered to the main turbine-generator, condensed and then pumped back to the boilers through a closed feedwater-heater system; (2) evaporation cycle, in which process steam for the refineries is generated from water supplied by them. In this cycle, high-pressure-turbine exhaust passes through copper-tubed evaporators to generate process steam at 160 lb, 50 F superheat.

Pumps at contact heaters No. 1 and 3 are booster and boiler-feed units on the same shaft driven by a 1675-kw auxiliary turbine, which also drives a 1000-kw induction motor that can be operated as a generator at light loads.

For the process cycle, water, first treated by softeners, passes through the feedwater-heating section of the condenser, a closed heater and a deaerating heater. From there, it is forced to the evaporators by the evaporator feed pump. This and the evaporator-condensate pump are on the same shaft driven by a single motor.

The makeup condenser, furnishing makeup to the high-pressure steam cycle, is regulated by throttling steam supply to a separate closed heater. This condensate is then pumped to a contact heater. Provision is made so that if makeup exceeds boiler requirements, condensate will be withdrawn just beyond the jet condenser. An auxiliary heater deaerates distilled water from storage before it is returned to the high-pressure steam cycle.

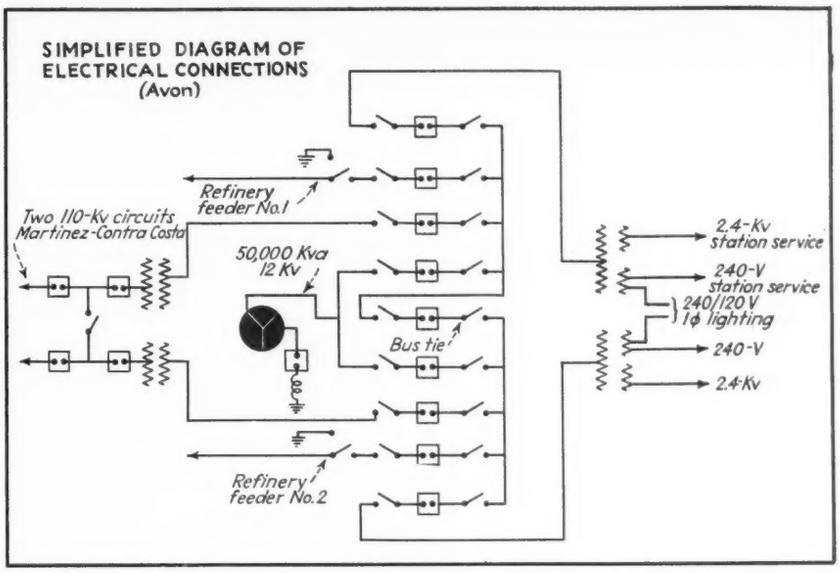
Each condenser (single-pass, divided-water-box) handles 300,000 lb of steam per hr with a heat release of 280,000,000 Btu per hr, giving a backpressure of 1.89 in. Hg abs when 37,500 gpm is circulated at 70-F inlet temperature. Cooling water at Avon and Martinez is obtained from a 12-section Foster Wheeler cooling tower; each section has a 25-hp, 220-volt, 2-phase, ac-motor-driven fan. The tower cools 37,500 gpm from 105 F to 90 F with wet bulb of 70 F. At Oleum, cooling water is pumped directly from San Francisco Bay.

When, under certain conditions, the turbine unit is on standby service, condensation of 15,000 lb of steam per hr and release of 15,000,000 Btu heats 300,000 lb of evaporator feedwater from 60 to 110 F at 3 in. Hg abs. This feedwater is warmed in a 4-pass heater housed above the tubes in the same shell with the main condenser.

Between the heater and the main tube bank are two shutters, inclined at 45 deg, one on each side of the condenser. These shutters consist of overlapping stainless-steel plates on shafts extending the length of the shell, parallel to but not coinciding with the center line of the plates. The shutters are counterbalanced to remain in closed position, separating the heater or standby section of the shell from the main or load-operation section until opened by predetermined pressure difference, thermostatic or load control, or combination of controls.

Each generator is a General Electric 40,000-kw, 0.8-pf, 50,000-kva, 3600-rpm, 12,000-volt, 3-phase, 60-cycle, hydrogen-cooled direct-connected machine. Shaft and pilot exciters are driven at 1800 rpm through a reduction gear; the former is rated 175 kw at 250 volts dc, the pilot 4 kw at 250 volts.

Hydrogen is circulated through the system by a fan on each end of the rotor. Water-cooling coils in the gas compartment remove heat from the hydrogen; rate of flow through the coolers with the generator operating at full speed is about 40,000 cfm. Hydrogen pressure is 0.5 lb, although design permits operation up to 15 lb to supply more than name-plate rating.



Electric energy feeds directly into a single 12-kv bus divided into two sections by a 2000-amp bus-sectionalizing oil switch. Each section connects to a feeder supplying the oil refinery, to a 6000-kva station-service auxiliary-power transformer and to a 25,000-kva, 115-kv transformer supplying the outgoing transmission system.

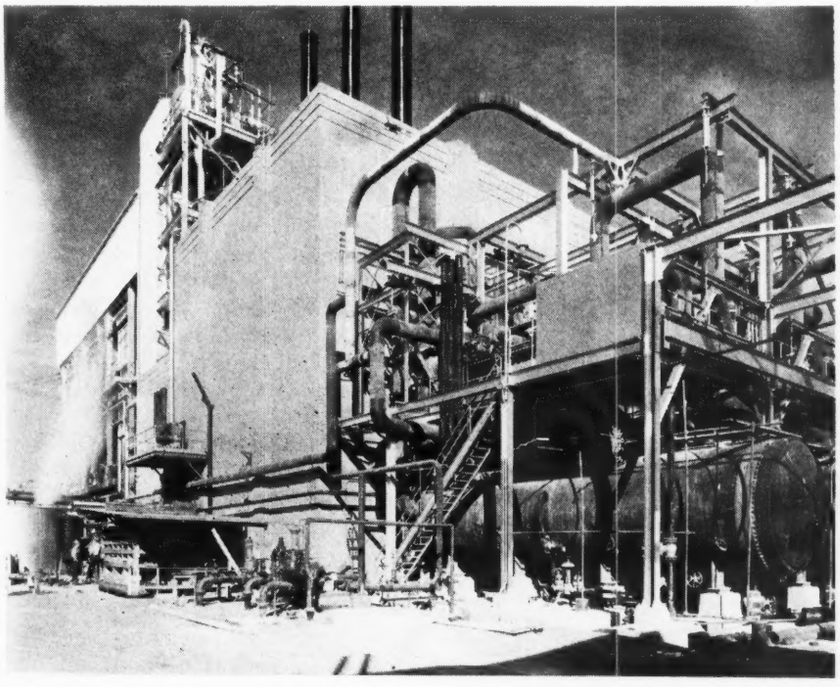
Power from Avon to the Tidewater Associated Oil Co refinery is supplied over two 12-kv feeders leading directly from the bus to a transformer bank consisting of four 2500-kva, 12/2.3-kv transformers, one a spare. For Martinez and Oleum, however, the 12-kv feeders supply two 3-phase, 12/2.3-kv transformer banks at each oil refinery. One bank is rated 7500 kva, the other 4000.

Station-service requirements are met by a bank of two 3-phase, 6000-kva, 3-winding transformers with a 12-kva primary, a 4500-kv, 2400-volt, 3-phase secondary and a tertiary winding of 1500 kva supplying 1305 kva, 3-phase, 240-volt power and 195-kva, 240/120-volt, single-phase, 3-wire power. One transformer can supply the entire station load; both, however, are energized during operation.

The 110-kv equipment consists of two 3-phase, Westinghouse transformer banks, each rated 25,000 kva. Transformers are self-cooled with nitrogen-gas cushion to prevent oxidation or sludging of oil. Pacific Electric oil circuit breakers are 115-kv, 600-amp, 1,000,000-kva interrupting capacity.

All switchgear is metalclad, cubicle type. On the 12-kv system, oil circuit breakers are 15-kv units with an interrupting rating of 1,000,000 kva. On the 240-volt system, the single bus is separated by a carbon air-break sectionalizing circuit breaker.

Controls for boilers, service pumps, many steam and water valves are in the main control room along with the standard electrical controls. Switchboards are steel panel, totally enclosed, with semi-flush-mounted instruments, meters and relays, arranged in a modified hollow square to centralize operation and provide minimum traveling distance for the station operator.



Ten evaporators (Foster Wheeler) are installed at the three stations; three each for Avon and Oleum and four for Martinez. Each has 7500 sq ft heating surface and will produce 102,000 lb steam per hr with heat head of 17 F. Shells are welded steel, 9 ft diameter by 40 ft long. Coil tubes are arsenical copper. Photo above shows location outdoors alongside turbine-room wall. Construction is typical of refinery practice with neither walls nor roof.

Oil, Oil-Poor and Oilless Circuit Breakers

How five modern medium- and high-voltage, high-capacity circuit breakers operate—some use a lot of oil to interrupt the circuit, others a small amount and others use none

By B P BAKER
Circuit Breaker Engineer, Westinghouse Electric & Mfg Co

▶ HIGH-VOLTAGE CIRCUIT BREAKERS, like other protective devices, must stand in readiness to perform their duties without hesitation and at an instant's notice. Whether operated manually as a switch, or automatically to remove a short circuit, the circuit breaker must quickly insert an insulating gap into the circuit. Two steps are involved in doing this: First, to break the continuity of the metallic circuit by separating the contacts, and second, to extinguish the arc formed between the contacts.

Numerous methods have been developed for interrupting an arc, each leading to a general design applicable to some specific circuit-breaker structure for a required current and voltage. High-voltage circuit-breakers may today be grouped into three classes: oil, oil-poor and oilless. A list of important designs includes the Deion-grid and Deion types.

The Deion-grid construction is suitable for voltages of 15 to 230 kv and for interrupting capacities up to 2.5 million kva. A Deion grid consists of an assembly of slotted insulation plates, Fig. 1, with one or two iron plates in the assembly, to control the action of the magnetic field around the arc. One of these assemblies is mounted on each stationary contact of the breaker, Fig. 2. When the breaker opens, an arc is drawn near the mouth of the slot. Because of the shape of the iron plates the magnetic field around the arc moves to the back end of the slot, carrying the arc with it. When the arc is first formed the slot is full of oil. As the arc vaporizes the oil in the back of the slot, the vapor is forced out through the arc as the latter is pulled back into the slot by the magnetic field. Gas passing through the arc removes ions from it and causes it to be extinguished.

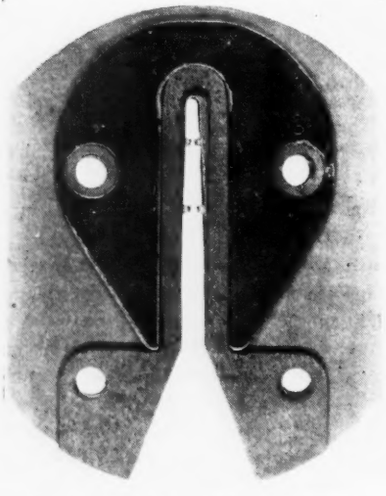


Fig. 1—One plate for a Deion grid

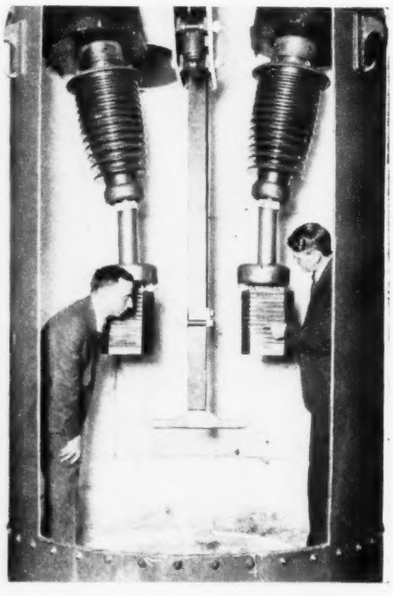


Fig. 2—Deion grids on oil circuit-breaker contacts interrupt 1.5 million kva at 15 kv

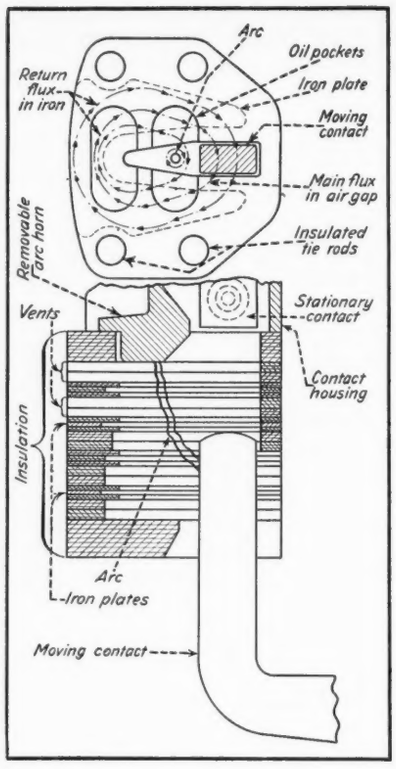


Fig. 3—Direction of magnetic field and motion of arc in a Deion grid

Grid Construction

Fig. 3 shows one contact of a 3-pole, 15-kv, 1.5-million-kva oil circuit breaker equipped with Deion grids. This diagram indicates the general construction of these grids and the way in which the arc is drawn between stationary and moving contacts. As the latter moves downward toward the fully open position, the arc is drawn in the slot of the grids. Walls of the slot into which the arc is drawn are filled with indentations or oil pockets.

The magnetic field surrounding the arc reacts with the induced field in the iron to force the arc away from where it is drawn toward the back end of the slot, as previously described. Since the slot and oil pockets are filled with oil, the arc is constantly forced against a solid wall of oil and in close contact with the oil trapped in the pockets.

Intimate contact between the arc and oil causes an intense intermixing of cool oil, gas and vapor with the arc stream. When current zero is reached,

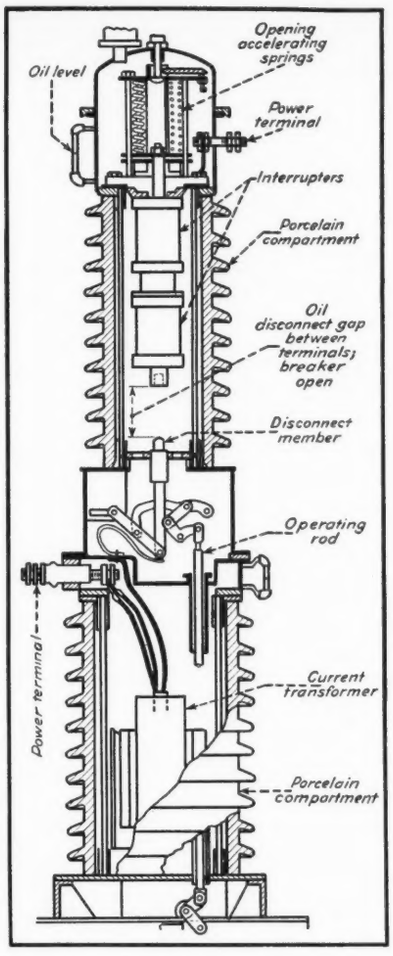


Fig. 4—One pole of a vertical-flow, oil-poor, 139-kv, 1.5-million-kva breaker

the arc stream consists of a highly turbulent mixture of oil, gas and vapor most favorable to a high rate of cooling and deionization of the arc, a condition necessary for quick arc extinction. Length of grid, length of slot, size and location of vents, size and arrangements of the iron plates are all determined by the voltage and current requirements of the grids.

Capacities

Deion-grid oil circuit breakers are built to interrupt 2.5 million kva at 230 kv. These breakers have three arc-interrupting elements in series suspended from each terminal. Each element consists of a stationary and a movable contact and a Deion grid, similar to Fig. 3. This particular breaker has six contacts in series instead of two shown in Fig. 3. This permits the breaker to interrupt over 6000 amp at 230,000 volts with only 0.5 cycle of arcing. Where high speed is required there is an advantage in using a number of lower-voltage grids in series rather than a single long high-voltage one.

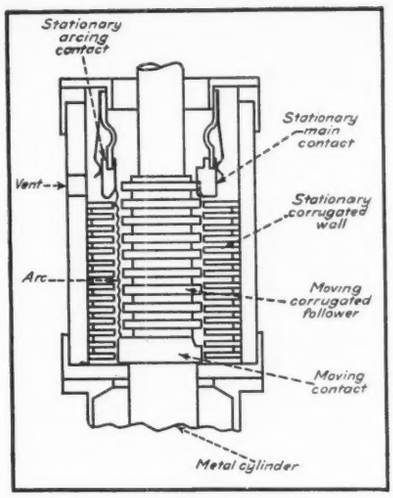


Fig. 5—Upper vertical-flow interrupting element of breaker pole shown in Fig. 4

Fig. 4 shows one pole of a 138-kv, 1.5-million-kva, oil-poor circuit breaker. It consists essentially of two separate porcelain-clad compartments; the lower one provides insulation to ground and houses the current transformer, the upper compartment forms the insulation between terminals and contains the interrupting elements and a disconnect gap under oil.

One of the high-tension leads of the current transformer, supported on the floor of the lower compartment, comes out through the metal casing and forms one power terminal of the breaker; the other extends upward into the metal casing, where it connects to the disconnect member. This disconnect member engages the interrupting element when the breaker closes.

Interrupting Element

The interrupting element, consisting of two vertical-flow interrupters (Fig. 5), connected in series, is suspended from the top metal casing that forms the other breaker terminal.

When the breaker closes the disconnect member rises from the metal casing between the porcelain compartments, moves about 9 in. through oil to engage the moving element of the interrupter and pushes the contacts to the closed circuit position. When opening, this sequence is reversed by first full separation of the interrupting contacts and then removing potential from them by opening of the disconnect member.

Oil in the interruption chamber is entirely separate from that in the lower or current-transformer compartment. Each interrupter consists of an insulating tube or cylinder with metal fittings at either end, Fig. 5. In the upper end of each cylinder is a chamber into which the stationary contacts are built, and is vented to the outside. Below the stationary contacts the cylinders are lined with fibre washers of different inside diameters to form a corrugated well into which the moving contact and its corrugated follower plunges when the breaker opens. The corrugated follower fills the well except for a small opening on one side into which the arc is drawn.

When the breaker opens, the metal cylinder just below the moving contact moves out of the well as the contact and follower move in. The cylinder area is less than that of the follower. Consequently, as the arc is drawn down into the well, oil is forced vertically up through the small corrugated passage, and made to flow parallel to and surrounding the arc. This flow of oil carries with it the hot ionized gases almost as fast as they are formed and interrupts the arc quickly.

Compressed-Air Type

Fig. 6 shows a 3-pole, indoor-type, compressed-air, high-voltage circuit breaker with two of the arc shutes removed. The breaker utilizes compressed air both to extinguish the arc and to operate the mechanism. Air is stored in the tank and is supplied from auxiliary compressor equipment. Operating impulses, transmitted to the breaker

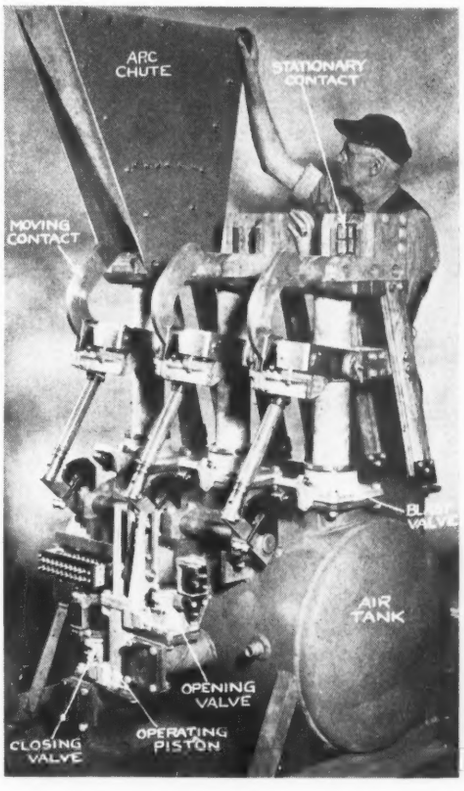


Fig. 6—Compressed-air, high-voltage circuit breaker with two arc chutes removed

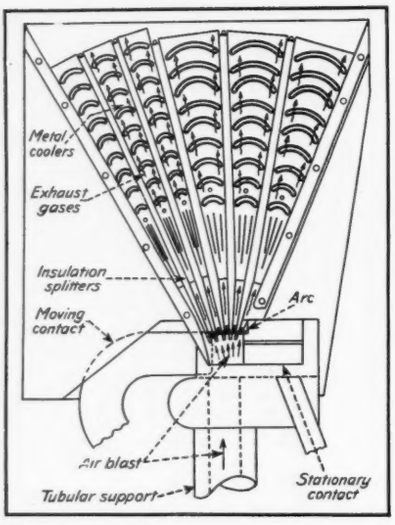


Fig. 7—One of the arc-interruption elements of circuit breaker shown in Fig. 6

Fig. 8—Deion plate for a 15-kv, 1.5-million-kva, air-break circuit breaker

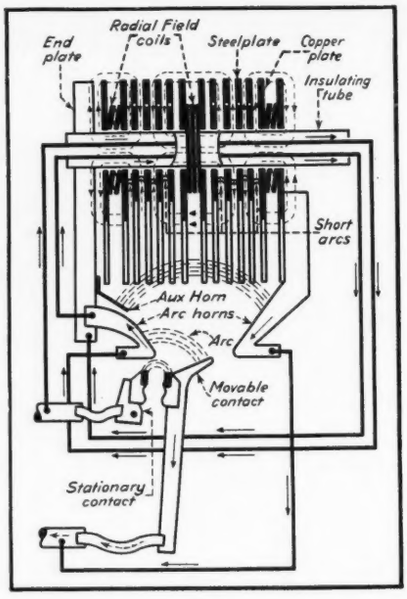


Fig. 9—Interrupting element of a Deion air-break circuit breaker showing contacts, blow-in magnetic field and coils, radial field coils, and their relation to copper, iron and insulated plates

electrically, operate small pilot air valves. These in turn control larger valves which open or close the breaker by applying air above or below a piston, respectively. The piston and cylinder are adjacent to and in front of the air tank. To close the breaker the piston moves up, rotating a shaft to which is attached moving contacts of all three poles. Motion is reversed to open the breaker. Air moves in a straight streamlined path from the tank through the blast valves, conducting tubes, across the arc, between splitter plates, through the coolers and into the receiving chambers. Absence of bends and turns keeps down friction losses where velocities approaching that of sound are used.

The interrupting element, Fig. 7, consists simply of fibre-plate arc splitters placed perpendicular to the arc stream and substantially parallel to the arc flow. Between these splitters are spaced suitable metallic coolers for extracting energy from the hot gases and deionizing them sufficiently for release into the upper receiving chamber. The arc is drawn across the edge of the splitters, where it is forced to remain until current zero.

During the time the current is flowing, the cloud of hot gas normally surrounding an arc is carried off by the air blast as fast as it is formed. As current zero is approached the last trace of hot ionized gas is caught between the air blast and the ends of the fibre splitters where it is cooled and deionized so rapidly that restriking of the arc is usually prevented and the circuit cleared after the first current zero.

Deion circuit breakers are an air-break type with interrupting capacities up to 1.5 million kva at 15,000 volts, and are totally different from Deion-grid oil circuit breakers. They both take ions out of the arc stream to interrupt it, but they accomplish this in different ways. The Deion air circuit-breaker whirls the arc to death in a deionizing chamber by causing it to rotate over metal plates. During this period the arc moves so fast that there is no time for burning, while at the same time it is drained of its ions by the cooling plates and extinguished when current reaches zero.

The interrupting-element deionizing chamber consists of a stack of slotted copper plates partially surrounded on their outer periphery by steel plates of the same thickness, Fig. 8. Each layer consists of one steel and one copper, spaced from the next layer by insulating material so that the grooves formed by the slots in the copper plates terminate in annular spaces between them. Groups of these plates are spaced apart by coil sections constructed and connected to produce a radial magnetic field across the annular spaces between the copper plates. Heavy copper conductors disposed around the entire assembly produce a magnetic field in the arc-drawing chamber, Fig. 9.

When the contacts separate the short arc immediately rises to an arcing horn in series with the heavy copper conductors, Fig. 9. The field thus set up moves the arc along the arcing horns, where it is lengthened and brought into contact with the slotted ends of the copper plates. When the arc impinges upon the copper plates the coils producing the radial magnetic field are energized and the arcs are forced by this field to move around the annular spaces between the copper plates at very high velocity until the zero of the current wave approaches, when arc extinction occurs.

Another design of Deion air circuit breaker is very similar to Fig. 9, except that the interrupting element is considerably simplified and is good for about 250,000 kva at 5000 volts. The same type of contact system, arcing horns and blow-in field are used. The deionizing chamber of the interrupting elements consists of spaced slotted ceramic plates. Except for a slight staggering the slots register to form a pointed groove into which the arc is blown by the magnetic field. Cooling action of the creamic plates, together with air flow produced by magnetic field on the arc, result in effective arc extinction.

✦ ✦ ✦

Self-Starter for Southwark

Station power supply for new 300,000-kw Southwark Station of Philadelphia Electric Co will be made entirely independent of any outside source by the installation of two Allis-Chalmers 15,000-kw house turbines. Gasoline or diesel sets will start oil pumps and other auxiliaries. Running the house turbines during regular operating periods will make entire nameplate capacity of main turbines available to distribution system.

How Does High-Temperature Cooling Affect Gas-Engine Operation?

Improvement in mechanical efficiency, lubrication, and liner wear reported for "vapor-phase" cooled engines by M H Clark in July POWER explained here by analysis of relation between jacket and cylinder-wall temperatures

▶A MAJOR QUESTION arising out of the use of high-temperature cooling systems for internal-combustion engines is "what is the effect of higher jacket temperatures on engine operation?" An abstract of a paper by Manley H Clark, published last month in POWER, included test results showing that metal temperature in the "hot zone" was not affected by jacket-water temperature but depended entirely on the boiling point of the liquid used for jacket-water cooling.

The reasons for this situation are not obvious and to show clearly how this condition can be explained, we asked Mr Clark for further information. The following discussion is based on an interpretation of material supplied by Mr Clark and by J H Wallace of the Pacific Enterprise Products Co, who developed a patented system of high-temperature cooling known as "vapor-phase cooling," and on data from other authorities.

Typical Temperatures

First consider a single engine cylinder and its water jacket. The curves of Fig. 1 show typical temperature conditions within a cylinder operated on the 4-stroke cycle, at 50 and 100 mep. A rapid temperature rise takes place during the combustion period and a gas temperature of about 3700 F might be reached, in an average engine operating at 75 mep, after the piston has passed top center and is on the down stroke (expansion or power stroke). Thus, highest metal temperatures are encountered at top of the cylinder, in the so-called "hot zone," above the upper travel of the top piston ring, or about the upper quarter of the liner.

Because of high temperature, heat flow from the gas to the liner and through the cylinder wall to the jacket water will be at an extremely high rate —tests show it about 50,000 to 150,000 Btu per sq ft per hr. The quantity of water passing through the jackets is usually adjusted so that a temperature increase of 20 F in the passage through the jackets will absorb the total amount of heat given up by the engine through the cylinder walls.

However, such a temperature rise is entirely inadequate to absorb the heat flowing out from the combustion zone. A temperature rise of 20 F means that 1 lb of water will absorb 20 Btu. However, the same lb of water will absorb 970 Btu in turning from water to steam. It would thus seem that the best way to account for the high rate of heat absorption from the upper part of the cylinder is to assume that part of the water in the jacket boils. Tests have shown that local boiling is found at the hottest parts of the cylinder on most engines. The steam bubbles formed are condensed later by contact with cooler water in other parts of the jacket.

In considering this situation, it is important to distinguish between rate of heat transfer from gas to water, and rate of heat absorption by the water. Rate of heat transfer depends on the over-all temperature difference and on the coefficient of heat transfer. It might be argued that if we assume boiling occurs and water temperature in the upper part of the jacket at the cylinder wall is thus 212 F, then temperature difference between gas and water has been reduced and rate of heat transfer has been reduced proportionately.

This is true, but unimportant, as examination of the figures will show.

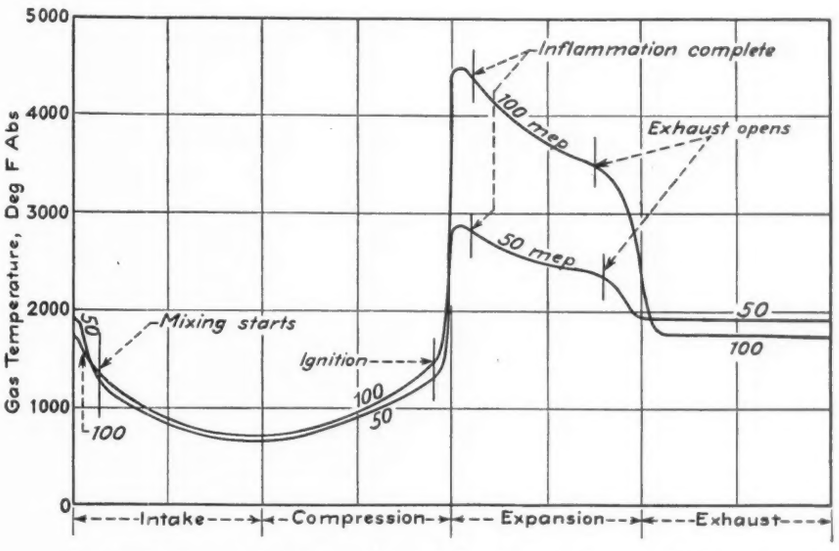


Fig. 1—Temperatures in gas-engine cylinder at various stages of the cycle

With a gas temperature of 3700 F and a water temperature of 212, over-all temperature difference is 3488 F. If water temperature were say, 70 F, an extremely low figure, over-all difference would be 3630 F. The percentage difference between these two temperature drops is about 4%, relatively insignificant.

However, if boiling occurs we have a change in the heat-transfer coefficient to consider. Heat flowing from the gas in the cylinder to the jacket water en-

counters three resistances: (1) the film at the inside cylinder wall, (2) the cylinder wall itself, and (3) the film at the outside surface of the cylinder. To force heat through each of these resistances requires a temperature drop and the amount of drop at each stage depends on resistance encountered.

Effect of Boiling

Now, if boiling occurs in the upper part of the jacket, it increases resistance of the film at the outside cylinder wall, because of bubble formation. Since over-all temperature drop stays roughly the same, drop through the outside film becomes relatively greater and other drops become relatively less. Over-all heat-transfer coefficient becomes considerably lower, so that with about the same over-all temperature drop, a lesser amount of heat flows from gas to water, per unit of area and of time. The net effect is a higher metal temperature, both inside and out.

If no boiling is to occur at the hot zone, water must be circulated at an extremely high rate, high enough to absorb the large amount of heat flowing out of the combustion zone. This amount of water is far more than needed in the other parts of the jacket and over-all temperature rise might be as low as 1 F. Obviously such an arrangement would be costly because of greater pumping and piping capacity required. Thus, in practice, a much smaller quantity of water is circulated and in most engines some boiling occurs at the combustion zone.

Metal temperatures in the hot zone will stay about the same in any given engine, because water temperature at that point is usually the same (212 F). Thus hot-zone temperature is independent of inlet and outlet jacket temperatures. Since this is the hottest cylinder temperature, it is one to be considered in judging a cooling system.

Jacket Under Pressure

As explained in last month's article, pressure is carried on the jacket-water system in the vapor-phase cooling set-up. This raises the boiling point of the water above 212 F. Consequently, metal temperature in the hot zone is increased. Since pressure increase is small, usually about 5 lb above atmospheric, temperature increase is only about 15 F. This is not enough to have any significant effect on liners or pistons. Thus, high-temperature cooling introduces no new mechanical problems.

What are the advantages of high-temperature cooling? The major gain, of course, lies in the improved heat recovery, since all recoverable heat can be delivered in the form of low-pressure steam. This aspect was fully considered in the previous article. However, several other advantages are claimed for high-temperature cooling.

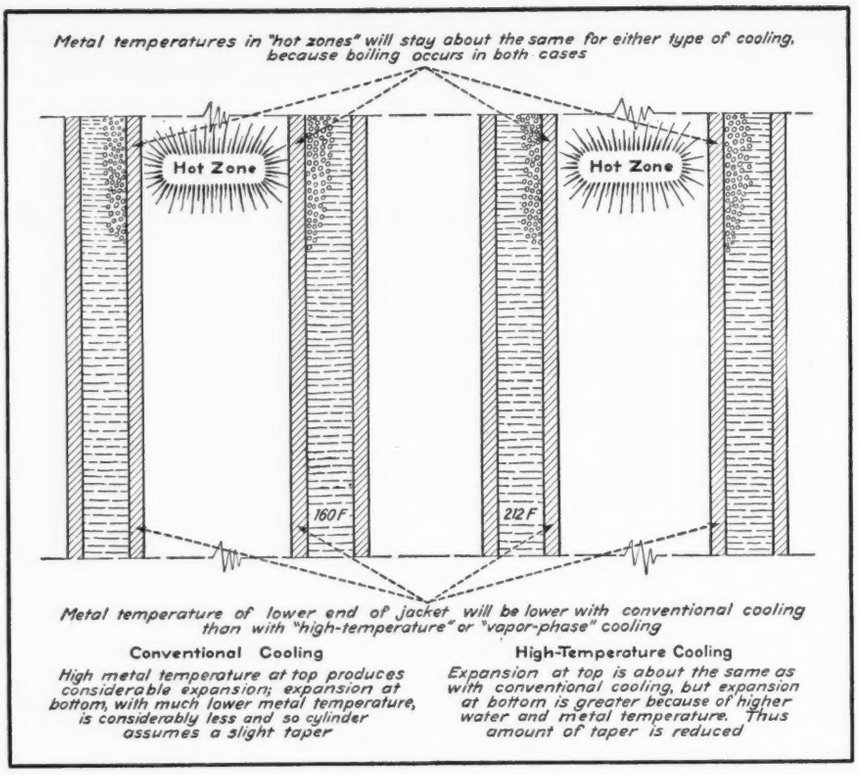

Metal temperatures in "hot zones" will stay about the same for either type of cooling, because boiling occurs in both cases
Hot Zone
Hot Zone
160 F
212 F
Metal temperature of lower end of jacket will be lower with conventional cooling than with "high-temperature" or "vapor-phase" cooling
Conventional Cooling
High metal temperature at top produces considerable expansion; expansion at bottom, with much lower metal temperature, is considerably less and so cylinder assumes a slight taper
High-Temperature Cooling
Expansion at top is about the same as with conventional cooling, but expansion at bottom is greater because of higher water and metal temperature. Thus amount of taper is reduced

Fig. 2—Effect of jacket-water temperature on liner distortion

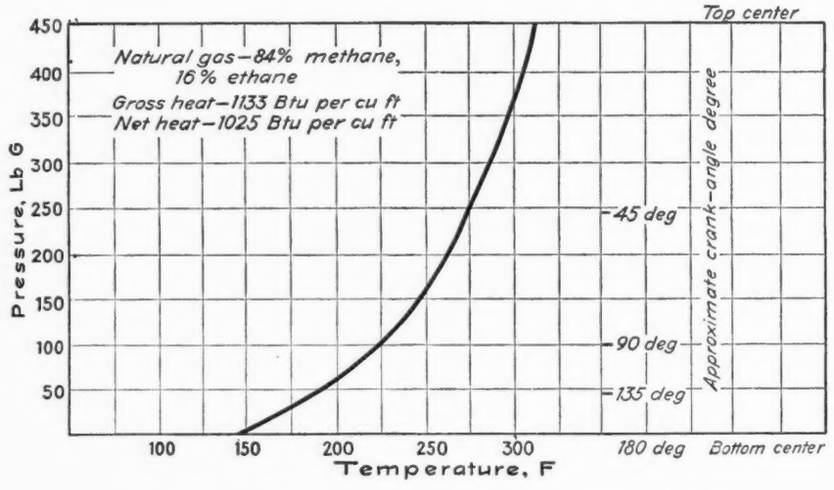


Fig. 3—Dewpoint of water in perfect combustion of natural gas

Tests indicate that high-temperature cooling produces a marked gain in mechanical efficiency (10% on some engines). The reasons for this can be seen by again examining the temperature conditions in a cylinder (Fig. 2). In an engine with ordinary cooling, we have fairly high metal temperatures at the top of the cylinder with considerably lower temperatures at the bottom. This means that expansion will be greater at the top and thus the operating cylinder will have a slight taper, being narrower at the bottom.

As high-temperature cooling has no marked effect on metal temperature in the upper or "hot" zone, expansion would be about the same. However, in the lower part of the cylinder, where jacket water does not boil, jacket-water temperature with high-temperature cooling is higher than with normal cooling and metal temperatures are higher. Hence expansion at the bottom is greater and cylinder diameter is more uniform. With the piston and rings fitted for tightness at the top, where the use-

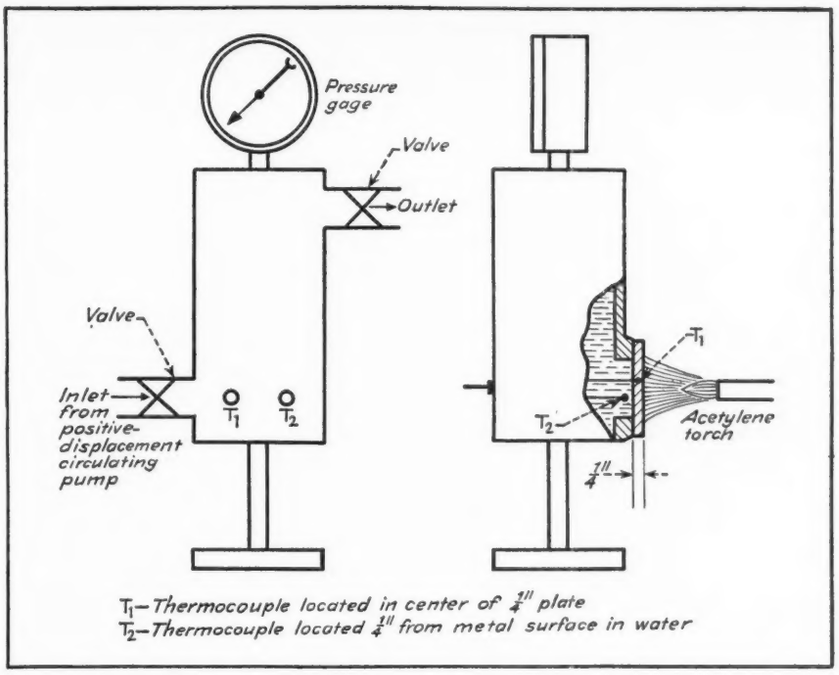


Fig. 4—Laboratory setup to determine relation between cooling-water temperature and metal temperature. Test results shown in July POWER were obtained on this equipment, which simulates engine conditions

ful pressure must be held, effect of the more uniform bore is to decrease the piston "drag" in the lower part of the cylinder and so increase mechanical efficiency. The British authority, Ricardo, who made some tests on high-temperature cooling, attributes the gain in mechanical efficiency to better lubrication resulting from the oil's freedom from moisture and sludge.

The fact that there is less piston drag seems to be borne out by the effects of high-temperature cooling on lubricating oil. Tests on automotive and high-speed stationary engines of the crankpin type, show that temperature of the main body of oil is lower than with ordinary cooling. In this engine, oil has only short contact with the hot-zone areas, dropping down into the pan, which is thermally insulated by the gasket, and ventilated. The lower temperature would seem to indicate that the oil absorbs less frictional work when high-temperature cooling is employed.

Higher Oil Temperature

In large engines, where the main body casting carries down to form the crankcase, the tests show slightly higher oil temperature than with ordinary cooling. This would seem to result from heat flow through the relatively large mass of metal involved and from lack of air circulation about the crankcase. Use of high-temperature cooling on such engines usually requires a supply of low-temperature water for the oil cooler.

In this country, high-temperature cooling was first studied as a means of eliminating lubricating-oil troubles with engines burning "sour" gas, containing a fairly large percentage of sulphur dioxide. This, as is the case with most natural gas, contains a considerable percentage of hydrogen, which burns to form water vapor. From a knowledge of the partial pressure of the water vapor in the cylinder, it is possible to estimate the temperature at which it will condense, or, as it is called, the "dewpoint." It is not necessary for gas temperature to reach the dewpoint for condensation to occur; condensation will take place wherever the gas containing the water vapor comes in contact with a metal surface having a temperature lower than the dewpoint.

The curve of Fig. 3 shows the dewpoint temperature for the water vapor formed from a typical natural gas, for various positions of the piston. In many cases, inside cylinder-wall temperatures with ordinary cooling are below the dewpoint, when the piston is in the lower position, and some condensation occurs. At the bottom of the expansion stroke, when the piston starts up, temperatures are still further lowered, and deposited moisture remains on the walls to be scraped off by the piston rings. If sulphur dioxide is present, its affinity for moisture will cause it to be absorbed by the water to form sulphur acids.

Water alone, or sulphur acids, acts as an emulsifying agent and the stable emulsion formed by intimate mixing with the oil works down into the crankcase where it is difficult to remove. This "sludge" forms particularly rapidly in engines burning sour gas, because of the large percentage of sulphur dioxide present. To a lesser extent, the same effect is found in virtually all natural-gas engines.

With high-temperature cooling, lower parts of the cylinder are maintained at higher temperatures than with ordinary cooling so that there is definitely less possibility of condensation. Thus tendency to sludging is reduced and life of lubricating oil increased.

Moisture and Wear

The part played by moisture resulting from condensation in causing liner wear is widely debated. In some engines corrosion seems to be the major factor in wear; in other engines, mechanical action seems to account for most of the wear. However, "Collected Researches in Cylinder Wear," published by the Institute of Automobile Engineers of Great Britain, in January, 1940, has this to say: "It was concluded that low cylinder-wall temperature was the cause of high wear, and this was confirmed by a large number of tests conducted under steady running conditions which showed a rise in rate of wear below a cylinder-wall temperature of 194 F. The increase in wear at low temperature is shown to be related to condensation on the cylinder walls of the water of combustion. It is pointed out that certain acids formed during combustion could accelerate corrosion. . ."

Further tests conducted as part of the British research program showed that cylinder-wall temperatures above 500 F produced no greater wear.

To date, little work has been done in this country on applying high-temperature cooling to diesel engines. Since most diesel fuels contain little hydrogen, condensation of water vapor is not as important a problem as in the gas-engine field, but it would seem that the gains in mechanical efficiency, and the advantages of producing low-pressure steam for process, would make it worthwhile to investigate high-temperature cooling for diesel engines in industry.

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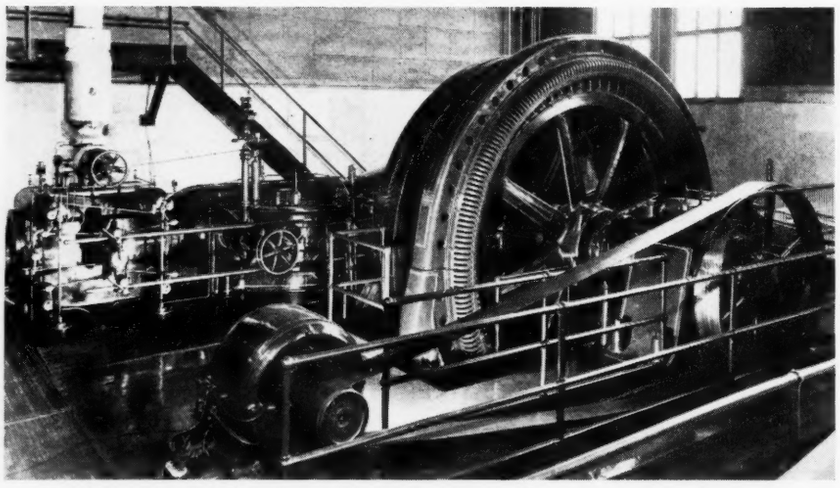
Alabama Adds 60,000 Kw

The Alabama Power Co has announced plans for construction of a 60,000-kw unit at its Gorgas steam plant, to be ready by May 1, 1943. Completion of new plants at Chickasaw and Gorgas will bring the utility's steam-plant-capacity to 294,000 kw.

New Boilers for World's Largest

Boiler-room modernization has improved operation by permitting use of low-priced fuel, by increasing power and steam output, and by eliminating use of live steam for process

By LLOYD A CORWIN
Chief Engineer and General Superintendent
Froedtert Grain & Malting Co Inc
Milwaukee, Wis.



▶ ABOUT 1868, a boy named William Froedtert came to this country and settled in Milwaukee, where he served an apprenticeship in the flour and feed business. After a few years he joined his brother Jacob to form the Froedtert Brothers Commission Co. A decade later they entered the brewery field and, as was the custom in those days, they manufactured their own malt.

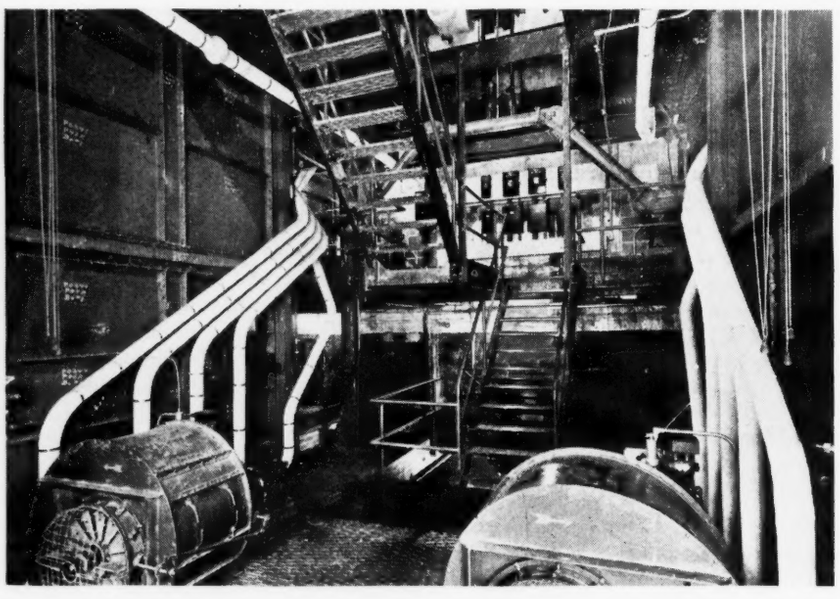
A serious fire destroyed the brewery and left only an extremely old-fashioned malt house. And yet this malt house, with a capacity of 50 bushels per day over an average 8-month year, formed the nucleus for the present Froedtert Grain & Malting Co, largest in the world, with a yearly production capacity of 12,000,000 bushels and with 9,000,000 bushels of elevator and storage space.

In the early days when modern machinery was unknown, the brothers and one extra man both managed and worked the business. After the early death of his brother, William Froedtert carried the entire responsibility and it is largely through his practical and progressive management and adaptation to new and scientific methods that the company has grown to its present position. His son Kurtis now carries on the family tradition.

Rapid plant expansion, to keep pace with new methods for greater efficiency, economy and high product quality, marks the past 15 years. These new methods have meant many changes in production and distribution of power, steam, water and air, culminating in a power-plant rebuilding program begun in 1940. This program, fifth power modernization in the company's history, has centered in the boiler house; the next step is revision of generating facilities.

Existing Plant—The total present load of about 2200 kw is met by purchased power and the output of two engine-generator sets (400 and 500 kw respectively). Vilter heavy-duty corliss engines drive 480-volt, 3-phase, 60-cycle Allis-Chalmers generators. Purchased power comes into the plant as a primary service at 3810 volts, being dropped to 480 volts in a substation. This service is tied through the board so that generator units can be synchronized with purchased power.

These units were formerly supplied with steam by three 2360-sq-ft Kidwell 4-drum water-tube boilers, fired by Combustion Type "E" stokers burning Eastern coal. In addition to that supplied to the generating units, some live steam was supplied for heating. Two 1350-sq-ft hrt boilers were also operated to supply needs of the malting process.

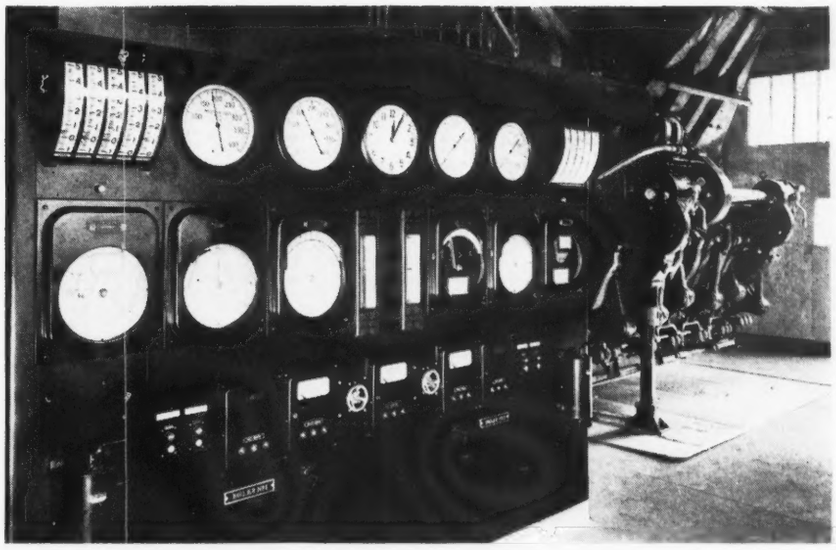


Boilers—Inability of the old plant to supply growing steam needs led to a decision to remove the old units and to install new capacity sufficient to meet present demand and to take care of reasonable future increases. The two new units are 6500-sq-ft, 3-drum, 3-pass water-tube boilers complete with superheaters, economizers and watercooled furnaces fired by multiple-retort under-

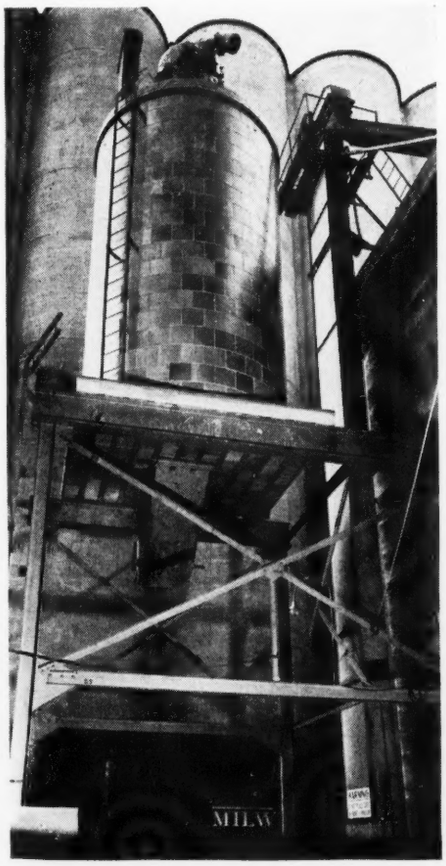
Malting Co

feed stokers. Designed for 250 lb and 500 F, the new units have a guaranteed efficiency of 83% at 250% rating, with coal having an average heating value of 11,850 Btu per lb.

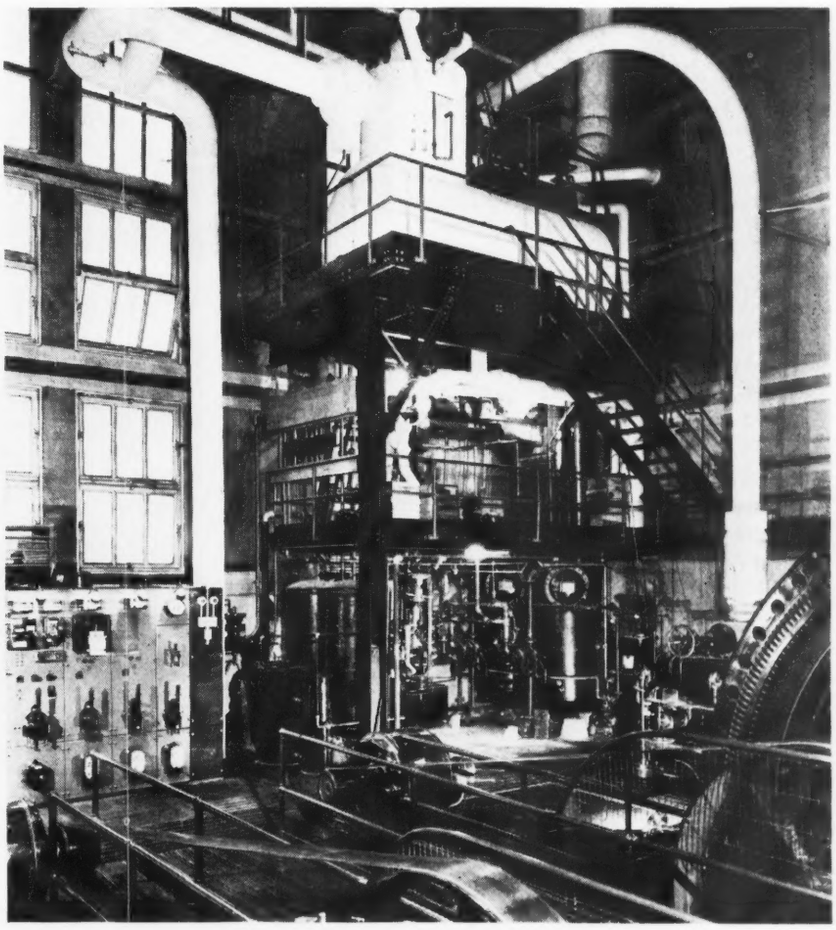
Until turbines are installed, now planned as the next step in the program of modernization, these boilers will operate at 160 lb and 400 F. This increase over the old operating conditions of 140 lb, saturated, is handled by the existing prime movers without difficulty by using special lubricating oils and lubricating equipment.



Combustion Control—A complete combustion-control system, centralized on a boiler-operating panel, regulates stoker-motor speed over a 4-point range. Air-volume control is effected by louvre-dampers on the forced-draft-fan intake, the fan being motor-driven. A hydraulic coupling gives the necessary induced-draft-fan speed variation to maintain constant furnace pressure.

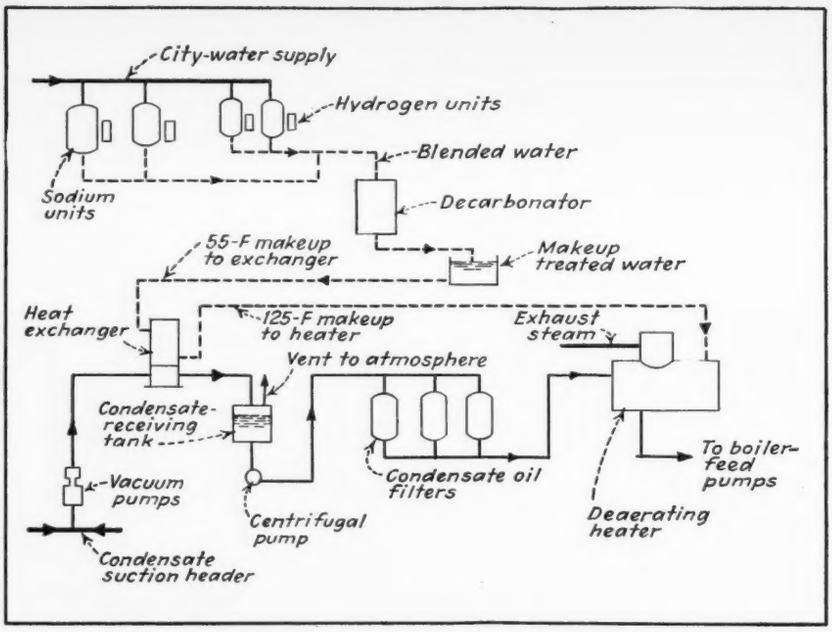


Coal and Ash Handling—Coal comes to the plant by either truck or rail and is discharged to a ground-level hopper. Redler conveyors lift the fuel to storage hoppers from where it is conveyed to a coal scale on each boiler. Conveyor movement is automatically controlled by coal discharge from the scales. A pneumatic conveying system carries ash from the boilers to a storage tank; from there it is discharged into either trucks or railroad cars.

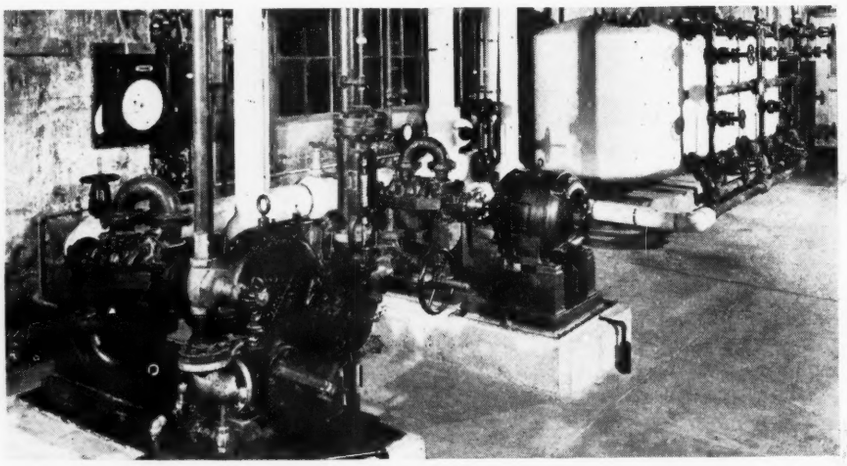


Condensate Cycle—All condensate from heating and process mains is pumped to a receiving tank (see diagram) for flashing and air release. A centrifugal pump takes suction from the receiving tank and discharges through a group of oil filters to the 105,000-lb-per-hr deaerating heater where it mixes with the treated makeup. Photo above shows the heater and feed-treating equipment.

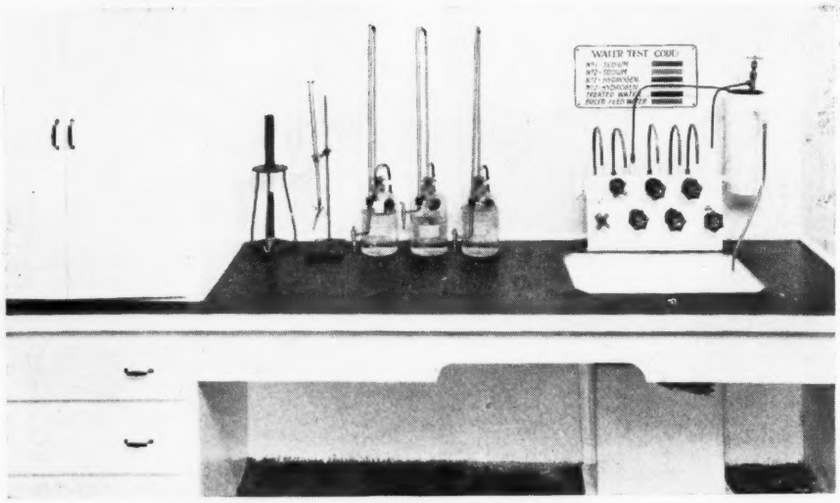
Water-Treatment Cycle — Boiler feed consists of filtered condensate and treated makeup from city-water supply. Raw city water for makeup passes through either sodium-zeolite units or hydrogen-zeolite units and the effluents from each side of the circuit are blended to achieve proper alkalinity before passage to a decarbonator and the treated-water tank. Passage through a heat exchanger transfers parts of condensate heat to the makeup water on its way from the tank to the deaerating heater.



Boiler-Feed Pumps—The two boiler-feed pumps draw their suction from the deaerating heater. One pump is turbine-driven and the other motor-driven; they are automatically interconnected so that a pressure drop in the line, signalling failure of the operating pump, causes the other pump to cut in, without interruption of service. Condensate filters can be seen at right.



Water Testing—No feedwater-treatment system is any better than the tests that control its operation. This fact is recognized at Froedtert; the complete and convenient test setup shown makes daily checks easy to run and insures accuracy in results.



PRINCIPAL NEW POWER EQUIPMENT

Boiler-House Extension, Froedtert Grain & Malting Co, Inc

ARTHUR G BEHLING, CONSULTING ENGINEER

Boilers — 6500-sq-ft, 3-pass, water-tube units	Erie City Iron Works
Combustion control	The Hays Corp
Boiler-feed pumps	Buffalo Forge Co
Induced- and forced-draft fans	Buffalo Forge Co
External feedwater treatment and conditioning	Cochrane Corp
Feedwater regulators (Copes)	Northern Equipment Co
Flowmeters	Cochrane Corp
Condensate filters	Cochrane Corp
Soot blowers	Vulcan Soot Blower Co
Coal scales	Richardson Scale Co
Coal-conveying equipment	Stephens-Adamson Mfg Co
Ash-conveying equipment	United Conveyor Co
Water columns and water gage	Reliance Gauge Column Co

THE OLD CHIEF

X—The Man Who Measures

Tenth in a series by William Doran, chief engineer, Essex County Sanatorium, Windsor, Ontario. Writing of the inspiration of the past, he has captured much of the human side of engineering that lies beneath the maze of power-plant costs and the wavy lines on paper disks

"Young man", said St Peter, "you can go down to hell with your mathematical principles"

▶ WHILE WORKING for the Old Chief, I saw many instances of the cash value of measuring, metering and weighing everything that came into the plant. I recall one day an alarming jump in our water consumption sent us all on a treasure hunt for the lost water—the problem was solved by the night engineer who traced it with an old ear phone and a steel rod.

It turned out that a new employee had been started on a process job and one of his duties was to empty and refill quickly a large cooling tank when the water became dirty, which would happen about twice a day. To speed up the job a large inlet and drain had been provided.

The man misunderstood his instructions and adjusted the drain valve and left the water running full bang, night and day. The moral of the story is that, had it not been for the Old Chief's propensity for measuring things, the loss might have run into a sizeable sum.

The Engineer Takes Over

And speaking of the engineer's place in industry, the Old Chief once told me the story of the three men who went to heaven—a lawyer, a doctor and an engineer. They appeared before St Peter as he stood in the time office of the Pearly Gates. The first man to step forward was the lawyer. With confidence and assurance he delivered an eloquent address which left St Peter dazed and bewildered. Before the venerable saint could recover, the lawyer handed him a writ of mandamus, pushed him aside, and strode through the open portals.

Next came the doctor. With impressive and dignified bearing he introduced himself. "I am Dr Jones."

St Peter received him cordially. "I feel I know you, Dr Jones. Many who preceded you said that you sent them here. Welcome to our city."

The engineer, modest and diffident, stepped forward and said, "I am looking for a job."

"Sorry," replied St Peter, "we have no work for you here. You can go to hell."

This response sounded familiar to the engineer and made him feel at home. "Very well," he said, "I have had hell all my life and I guess I can stand it better than the others."

"What on earth do you do?" asked St Peter.

The engineer recalled a definition and calmly replied, "I apply mathematical principles to the control of natural forces."

This sounded meaningless to St Peter and his temper got the best of him. "Young man," he said, "you can go down to hell with your mathematical principles and try your hand on some of the natural forces there."

And it came to pass that strange reports began to reach St Peter. The celestial denizens who had amused themselves in the past by looking down upon the antics of the less fortunate creatures in the inferno began asking for transfers to the other domain. The sounds of agony were stilled. Many new arrivals, after seeing both places, selected the nether regions for their permanent abode.

Puzzled, St Peter dispatched messengers to visit hell and report back to him. They returned all excited and explained: "That engineer you sent down there has completely harnessed the fiery furnaces for light and power. He has cooled the entire place with artificial refrigeration. He has drained the lakes of brimstone and has conditioned the air with perfumed breezes. He has flung bridges across the bottomless abyss and has bored tunnels through the obsidian cliffs. He has created paved streets, gardens, parks, playgrounds, lakes, rivers and beautiful waterfalls.

"That engineer you sent down there has gone through hell and has made it a realm of happiness, peace and industry."

High Cost of Steam

As for things engineers "go through," I will never forget the pipe trench extending under the cement floor of our old shop. It was 3 ft square with a trap door at the far end. It was an ordeal for men to make repairs in that trench because of the heat and restricted elbow room.

High, medium and low steam and returns were on one side, water services and waste lines on the other. It was a fitting monument to the gross stupidity of the contractor who planned it without consulting a practical engineer.

One day, as winter approached, a young and promising engineer was sent into the trench to close the drain and stop valves serving the lawn-sprinkler system. Unfortunately, while he was there, a mishap in the shop above caused a cast-iron elbow to snap in the medium-pressure line below. Despite an almost immediate shut-off and a gallant rescue, the lad died in the hospital a few days later. The trench was replaced by a tunnel of ample proportions.

In recalling the story, the Old Chief remarked that "the cost of steam was often very high in the old days."

Gear Rotary Pumps—Selecting

William A McGrath, Chemical Engineering Dept, Lehigh University, compares spur-gear and herringbone-gear units. Each has traits that makes it suitable for particular applications — this article shows how to decide which one it should be

▶ A ROTARY PUMP is a positive-displacement machine, particularly well suited to handle viscous liquids ordinarily difficult to pump with either centrifugal or reciprocating units. Positive-displacement also makes this pump useful where suction conditions prohibit installation of a centrifugal unit. In general, the liquid pumped must have some lubricating value because rotary pumps are essentially close-clearance machines; their internal surfaces must be well lubricated.

Although there are many types of rotary pumps on the market, a large percentage are double-gear rotary or modifications of this type. These units come under two classes, spur-geared. Fig. 1, and herringbone-geared, Fig. 2. Each has its own particular advantages.

Of primary importance in any installation is the over-all efficiency of the pumping unit. This efficiency is the product of the mechanical and volumetric efficiencies. Generally speaking, mechanical efficiency is a negligible consideration, because both herringbone- and spur-gear units have close clearances and similar stuffing boxes. The power involved in merely turning either of these units is about equal.

Correct Speed

However, mechanical efficiency of the pump as a whole, which is the equivalent power output measured as a percentage of the brake horsepower input, is greatly affected by viscosity of the fluid being pumped. Maximum pump speeds can be used on fluids up to 500 SSU viscosity, but much lower impeller speeds must be used with higher viscosities. A considerable amount of mechanical work is done on the fluid by the pump gears and unless the correct speed is selected, power loss in the pump may be high.

As far as volumetric efficiency is concerned, the spur-geared pump is normally the better performer except in cases of unusually high viscosities. Here again the difference is negligible because of the form and type of teeth in the pumping gears. Spur teeth have straight-line contact all across the face and when they engage there is a complete seal between suction and the discharge sides of the pump. Helical gears of either the single or double-helical (herringbone) types do not have straight-line contact and the result is an imperfect seal between the suction and discharge sides of the pump. For low-viscosity fluids a small amount will slip back through the helical teeth and therefore affect volumetric efficiency; for high viscosities the fluid itself forms a very effective seal.

Trapped Slugs of Air

On the other hand, straight-line contact across the face of the spur-gear pump has one great disadvantage—it may trap a slug of fluid in each tooth space, generating an abnormally high pressure in this space as each tooth goes through its cycle of engagement. This condition causes noisy operation, loss of power and may overload the bearings, but becomes less apparent as the face of the gears is reduced or as speed is decreased. Spur-gear rotary pumps are best used for comparatively small capacities and high pressures on fluids of low and medium viscosity. For moderate and high capacity and reasonable pressures helical-type gears give the best general over-all results.

Figs. 3 and 4 show the performance of a 2-in. rotary unit in which both types of gears were used for various fluid viscosities. All conditions were kept within experimental uniformity; rotor speed was 440 rpm for both pumps. The same casing was used in all tests; operating conditions and temperatures were kept constant. Fig. 4, representing the lower limit of the tests, is based on conditions below the customary viscosity range for rotary pumps. These curves are for a low-capacity pump. For similar pumps of greater capacity, variation in performance for the different types of impeller gears would not be as great with a 250-SSU fluid. However, the variation with a 250-SSU fluid for the larger pump would still be greater than with a 1500-SSU fluid.

Mechanical Differences

Some of the mechanical differences between spur and herringbone gears are of particular importance in relation to pump rotors. The line-contact of a spur gear, besides trapping liquid between the engaging teeth and thus making the spur gear noisier, also affects the bearings in that this constant stressing ma-

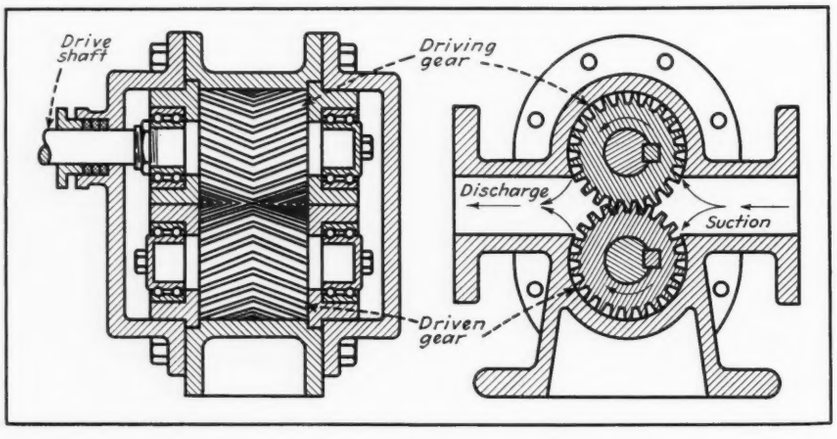


Fig. 1—Spur-gear rotary pump

the Right One for Your Job

terially shortens their life. The trapping or binding limits the speed at which the pump can be operated. Generally speaking, a herringbone-geared unit can be operated at least 100% faster than a spur-geared pump without detrimental effects on the life of the gears, bearings or stuffing box. Higher speeds result in a smaller pump per unit volume of liquid handled.

Helical-Gear Applications

In installations where the fluid carries a considerable amount of entrained air or vapor, or where occasional slugs of vapor come to the pump, helical gears will give best results. The reason is that, since liquid is not trapped in herringbone gears as in spur gears, there is a smaller amount of highly compressed vapor passing back to the suction. This vapor would, on passing between the teeth back to the suction, re-expand and cause incomplete filling of the suction chamber, which in turn would lower the volumetric efficiency of the pump.

Spur-geared units are particularly well suited to applications where viscosity of the fluid varies over wide ranges, usually the result of extreme temperature changes or dilution and concentration effects. The spur-geared pump will handle this condition quite satisfactorily and maintain a high volumetric efficiency, see capacity curves of Figs. 3 and 4.

Corrosion should always be considered in any installation. One must remember that, while several well-known manufacturers offer rotary pumps in corrosion-resistant materials, these pumps will show a decided decrease in efficiency in direct proportion to their increase in clearance caused by corrosion. No solid matter or grit of any kind can be handled with a gear pump because of close-running clearances. Abrasive materials soon destroy the clearances and pump efficiency. Small pieces of metal and other solid matter jam in the close clearances; result can well be a wrecked pump and the least that can happen is a seriously damaged unit that will probably be out of service for some time.

The plant engineer should, with the factors presented here, be able to make an intelligent analysis of his particular problem. Also, he should realize the importance of giving his manufacturer all available information covering the service conditions on which he desires to operate a rotary pump.

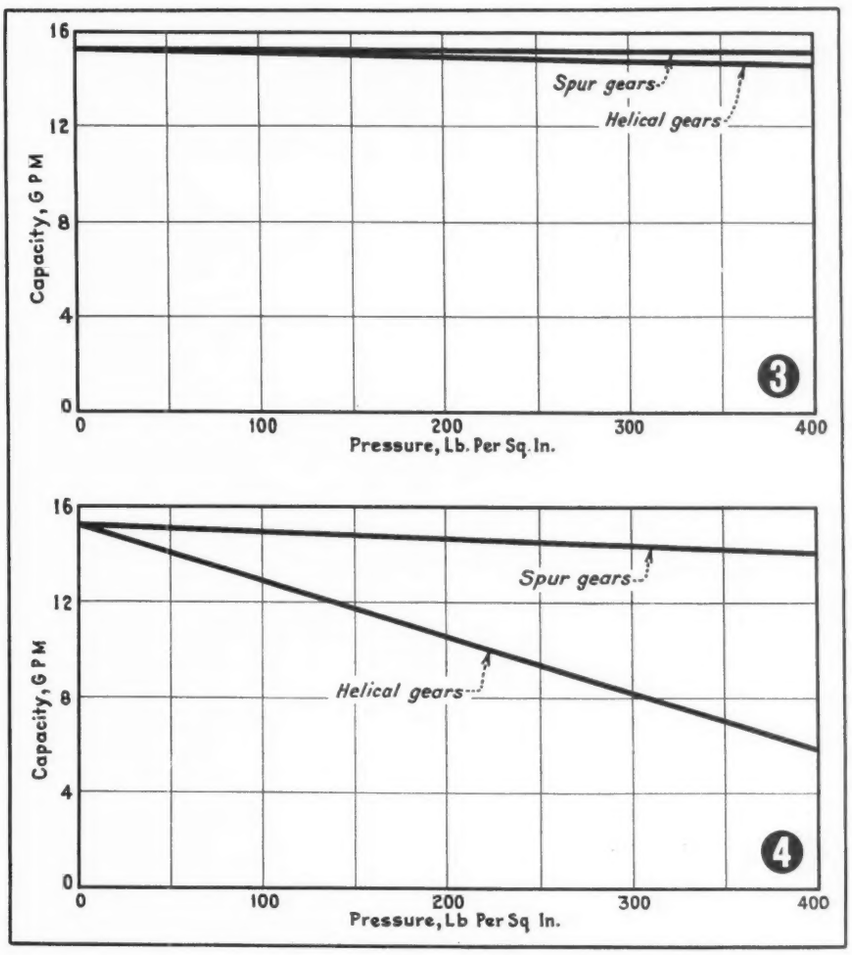


Fig. 3—Comparison of pressure-capacity characteristics of spur-gear and herringbone-gear units handling 1500-SSU oil. Fig. 4—Pressure-capacity characteristics of same pumps used in Fig. 3 test handling 250-SSU oil

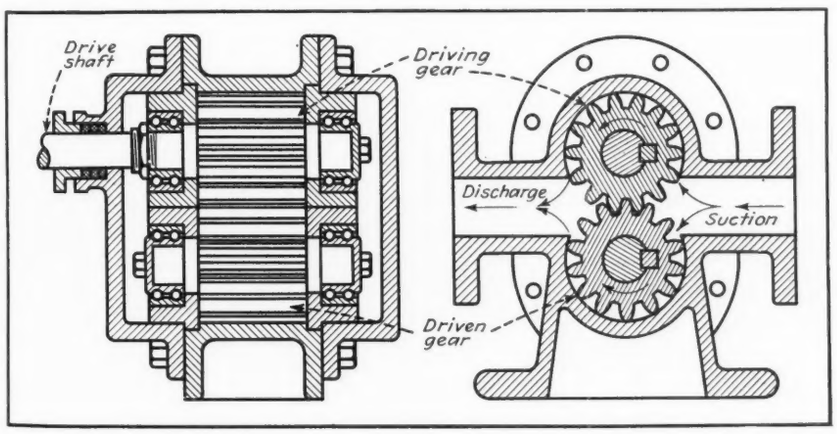


Fig. 2—Herringbone-gear rotary pump

How an Industrial Topping Plant Treats Feedwater

This is how the 600-lb topping plant of The Texas Co, Port Arthur, Texas, treats makeup water and deaerates boiler feed. Two years experience show good results

By HENRY FLYNN
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Assistant Power Engineer
Port Arthur Works, The Texas Co
and Boiler Feedwater Division
The Permutit Co

▶ THE 600-LB TOPPING PLANT of The Texas Co (see October, 1940, POWER, page 59, for description), designed by Jackson & Moreland, of Boston, Mass., is now operating in its second year with softened makeup. Steam from 300,000-lb-per-hr boilers is delivered to turbine-generators at 600 lb, 715 F, and then goes to a 160-lb pressure main supplying refinery equipment and some process requirements. Refinery equipment exhausts to process at 15 lb; any surplus exhaust enters a mixed-flow turbine at 10 lb.

Feedwater to the high-pressure boilers is 70 to 75% makeup; the rest is steam condensed in heating the feedwater, condensate from high-pressure heaters and condensate from the condensing mixed-flow turbine. The 3-drum high-head boilers have furnaces completely enclosed by water walls.

Makeup

Makeup from the Neches River is relatively low in hardness, fairly high in turbidity at all times and particularly turbid during cold weather and windy conditions. A typical analysis of raw water for normal conditions is given in Table I, Column 1.

Fig. 1 shows the equipment that had been used for treating feedwater for the old 150-lb boilers. Water was treated with aluminum sulphate as it entered the first compartment of the settling basin. In this compartment water was agitated to accelerate coagulation and to produce a strong floc. From the settling basin water was pumped through pressure filters and Permutit zeolite softeners to a soft-water storage basin.

† *See footnote to Table I for explanation.*

Coagulation requires from 35 to 85 ppm of aluminum sulphate and optimum coagulation takes place at a pH value between 5.7 and 6.8. At this pH the water has a slightly acid reaction; thus it was treated with 10 ppm caustic soda (12.5 epm/50)† after filtration to protect piping and the zeolite. This increased the pH value to approximately 7, as shown by Table I, Column 3. All of the equipment illustrated in Fig. 1 continues in use for the high-pressure boilers but additional equipment for further treatment was installed, see Fig. 2.

The coagulating and filtering plant of Fig. 1 had been in service several years before the Permutit zeolite softeners were installed. During this time the water was given a lime and soda treatment which caused a calcium carbonate incrustation to reduce the 16-in. pipeline to an effective size of 11 in. This pipeline, from treating plant to boiler house, is approximately 2 miles long. Since the zeolite softener went into operation

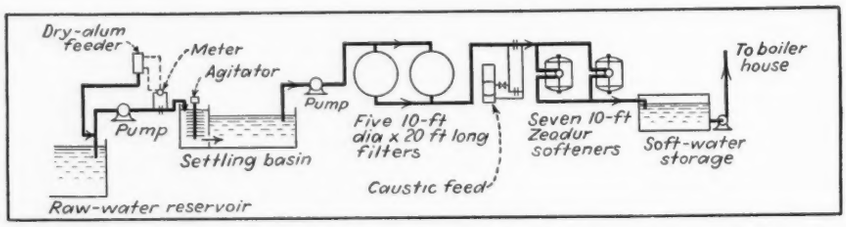


Fig. 1—This coagulating and filtering plant was installed several years before the high-pressure boilers went into service in the summer of 1939

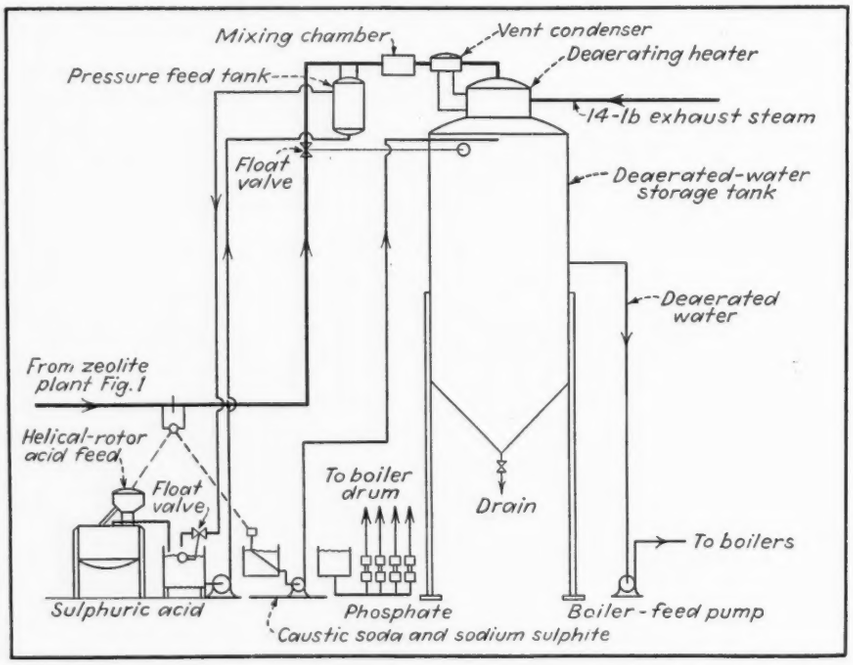


Fig. 2—Deaerating and chemical-treating plant, supplementing existing filter equipment shown in Fig. 1, for Port Arthur Works of The Texas Co

this deposit has been slowly dissolving.

Water leaving the zeolite plant has a hardness of 2 ppm, and at the boiler house this is increased to approximately 4 ppm. When selecting the treating plant for high-pressure boilers, the deaerated-water storage tank was designed to permit its use as a phosphate reaction tank to reduce this hardness. However, experience with the new plant has shown that with proper control of alkalinity and maintaining 40 ppm PO_4 (63 emp/50) in the boiler this amount of hardness does not form scale.

Depending upon the raw-water analysis and amount of alum fed for coagulation, it is at times desirable to reduce the alkalinity with sulphuric acid which gives a ratio of sodium sulphate to sodium carbonate of three to one with less total solids than if sodium sulphate were fed. When more than the usual amount of alum is used for coagulation, some additional caustic soda must be fed to make the sludge less adherent. Best results are obtained if the sodium hydrate in the boiler is at least 140 ppm (175 epm/50). Acid is fed into the pipeline ahead of the deaerator and caustic soda is fed into the deaerated-water storage tank.

Introduction of acid into the makeup water produces free CO_2, which lowers pH value of the water, making it corrosive to carbon steel. To protect the water-storage tank and piping, the spray-type deaerating heater, Fig. 3, must not only remove oxygen but also the free CO_2.

Deaerating Heater

Fig. 4 is a photograph of the deaerating heater mounted on top of the 750,000-lb deaerated-water-storage tank. Expansion of the water-inlet piping, Fig. 3, leading to the deaerating heater, is in a mixing chamber to insure thorough mixing of acid and water. This mixer, as well as piping between mixer and heater, is rubber-lined for protection against corrosion.

Spray valves are of non-corrodible 18–8 stainless steel. The spray-valve water box, the shell of the spray compartment and the vent-condenser shell are clad with 18–8 stainless steel integrally fused with carbon steel parent metal.

The first-stage or spray heater removes 95% of the oxygen in the feedwater and most of the free CO_2. This gives a water of sufficiently high pH value to permit using carbon steel for the steam scrubber and deaerated-water-storage compartment.

Effectiveness of this type of deaerator results from the fact that preheated water from the spray compartment and

TABLE I—WATER ANALYSES AT STAGES OF TREATMENT

		1	2	3	4	5	6	7	8
		ppm	*epm/50*†	*epm/50*	*epm/50*	*epm/50*	*epm/50*	*epm/50*	*epm/50*
Calcium	Ca	12	30	30	30	2	1.5	1.5	1.5	....
Magnesium	Mg	3.8	16	16	16	2	1.5	1.5	1.5	....
Sodium	Na	46	99	99	111.5	153.5	115	118	119.8	1797
Carbon dioxide	CO_2	3	7	34*	9	9	....	....	....	....
Bicarbonate	HCO_3	30	37	14	26.5	26.5	12	11	14.5	....
Carbonate	CO_3	..	..	..	....	....	8	10	3	48
Hydrate	OH	..	..	..	....	....	....	....	....	192
Sulphite	SO_3	..	..	..	....	....	....	2	2	30
Phosphate	PO_4	..	..	..	....	....	....	....	5.3	57
Chloride	Cl	73	103	103	103	103	77	77	77	1155
Sulphate	SO_4	5	5	28	28	28	21	21	21	315
		ppm								
Silica	SiO_2	4		4	4	4	3	3	3	45
Iron oxide and alumina	R_2O_3	1		0.2	0.2	0.2	0.2	0.2	0.2	....
Dissolved solids		149		149	162	162	121	124	126	1842
Turbidity		25		...	...	...	...	...	...	48
pH		7.3		6.1	6.9	6.9	8.8	8.9	8.8	11.4

Column 1 — Neches River, raw
Column 2 — Coagulated with 50 ppm $Al_2(SO_4)_3$. . 18 HO_2 (23 epm/50) and filtered
Column 3 — Treated with 10 ppm NaOH (12.5 epm/50)
Column 4 — No. 3 after softening by Zeo-Dur plus calcium pickup from pipeline
Column 5 — After deaeration and dilution with steam in heating plus 12% condensate
Column 6 — After adding (1.0 epm/50) NaOH and (2 epm/50) Na_2SO_3 to storage tank
Column 7 — Showing effect on alkalinity reduction by adding 3.6 ppm (5.3 epm/50) of hexametaphosphate directly to boilers
Column 8 — Showing effect of 15 concentrations in the boiler

* This quantity of free CO_2 would have been 53 epm/50 as a reaction of alum with bicarbonate if 19 epm/50 or 8 ppm CO_2 had not escaped to the atmosphere during agitation and standing in the coagulating basin.

† The analysis is reported in the ionic form in parts per million (ppm) and for convenience the ions are also reported in their "equivalents per million" divided by 50 (epm/50); expressing the substances in emp/50 is the same as expressing them in terms equivalent to calcium carbonate because the equivalent weight of calcium carbonate is 50. When an analysis is shown in emp/50, the sum of the metals—calcium, magnesium and sodium—must be equal to the radicals—HCO_3, CO_2, OH, Cl, SO_4, and PO_4. The hardness of water in ppm is the sum of the calcium and magnesium in epm/50 and the total dissolved solids are approximately equal to the sum of the calcium, magnesium and sodium in epm/50 plus silica.

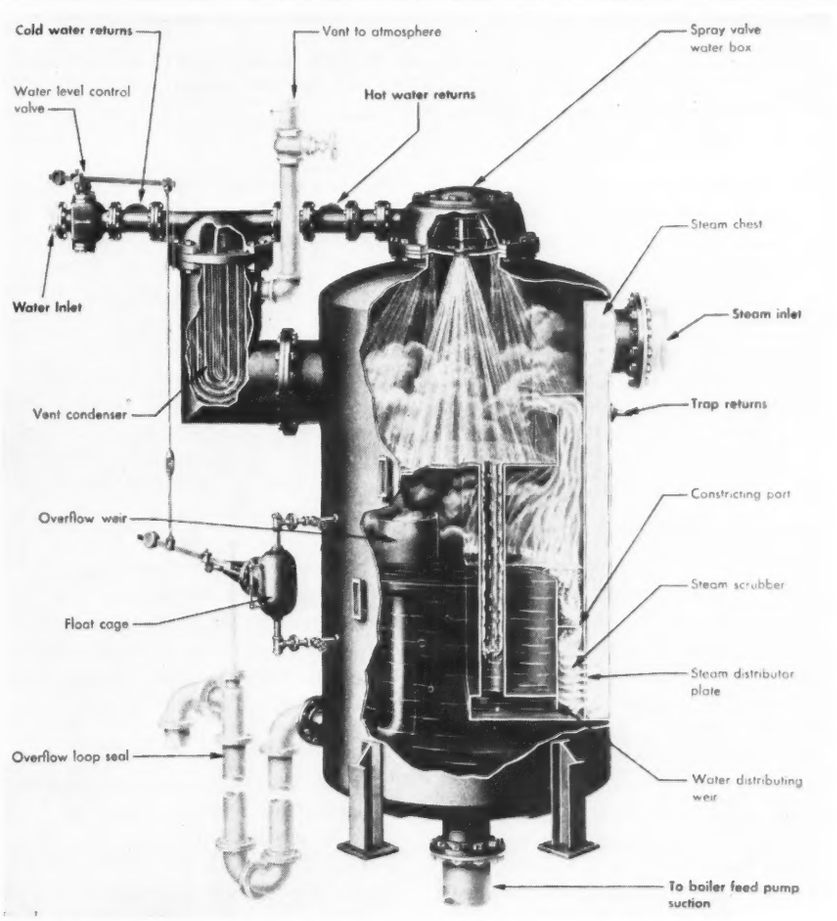


Fig. 3—Spray-type deaerating heater removes both oxygen and free CO_2

all the steam used for heating are both passed through the steam scrubber, which is long and narrow to insure intimate mixture. This method of deaeration differs from the "reboiler type" of deaerator where heating steam is distributed underneath the water surface by a perforated manifold. Here the hot

TABLE II—DEAERATING-HEATER PERFORMANCE

	Water entering deaerating heater							Water leaving deaerating heater					
			Alkalinity as $CaCO_3$						Alkalinity as $CaCO_3$				
No. of tests	Rate of deaeration lb/hr	Oxygen, cc/liter	Bicarbonate, ppm	Normal carbonate, ppm	Free CO_2 ppm	pH	Temp, F	Oxygen, cc/liter	Bicarbonate, ppm	Normal carbonate, ppm	Free CO_2	pH	% rated capacity
4	350,000	5.0	20	0	3	7.0	69	0.00	9	8	0	8.9	25
5	650,000	5.0	20	0	3	7.0	73	0.00	9	8	0	8.8	46
6	950,000	5.0	18	0	3	6.9	80	0.00	7	8	0	8.8	68
After feeding sulphuric acid into water inlet pipe ahead of heater													
2	650,000	5.0	10	0	8	6.5	80	0.00	4	5	0	8.5	46

The determinations reported are average readings for the number of tests reported in first column.

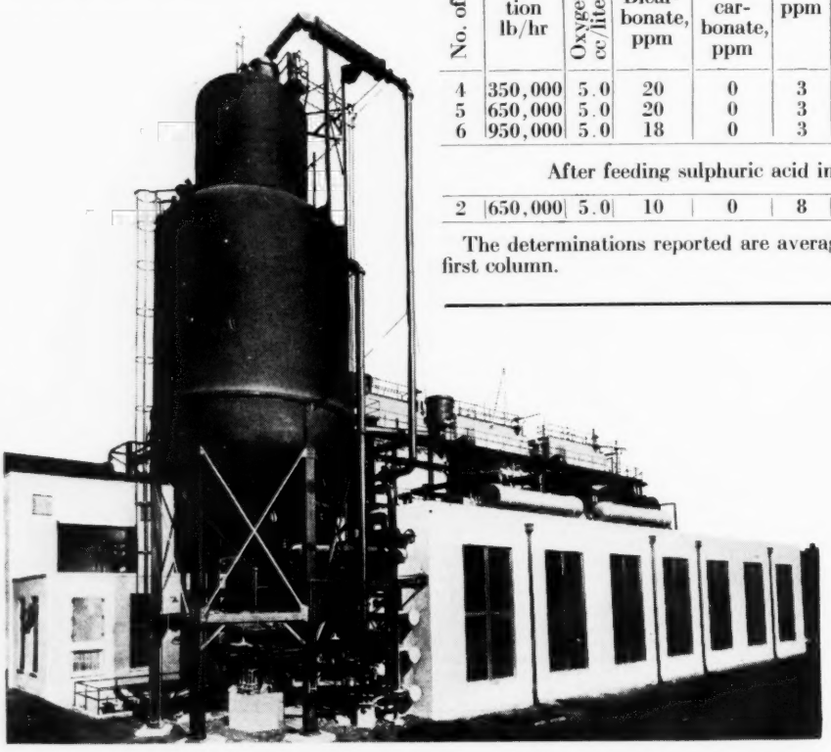


Fig. 4—Deaerating heater mounted on top of 750000-lb deaerated-water storage tank. One-story structure at right houses firing aisle, feed and fuel pumps, boiler controls. 600-lb steam-generating units are outdoor type

water is conducted to the steam scrubber, in which high velocities are insured and volume occupied by scrubbing steam is about 100 times the water volume. Steam passing through the scrubber is oxygen-free for complete deaeration. From the scrubber the steam enters the spray preheater, vent condenser for the scrubber. The spray heater is vented through a surface-type vent condenser through which the cold water enters.

Results of Tests

Shortly after the deaerating heater was placed in service and after the plant was operating nearly at its normal capacity, a series of careful tests were made to determine the effectiveness of the deaerating heater for removing free CO_2 and oxygen.

The results of these tests, Table II, are average for the number of tests reported in the first column. Alkalinity of the water is the sum of the bicarbonate and monocarbonate alkalinity. During the tests, conforming with normal operating conditions, all of the alkalinity was bicarbonate alkalinity and at least 3 ppm of free CO_2 was always present. For the first three series of tests no sulphuric acid was added and the total alkalinity varied between 18 to 20 epm/50.

As shown in Table II, deaeration removed all free CO_2 and changed approximately half of the bicarbonate alkalinity to monocarbonate alkalinity. The reduction of total alkalinity (sum of bicarbonate and monocarbonate alkalinity) reflects the effect of diluting the makeup water in the deaerating heater with steam used for heating and returned condensate. Removal of free CO_2 and production of some normal carbonates increased the pH value from approximately 7.0 to 8.8.

Alkalinity Reduced

For the last series of tests alkalinity of the makeup water was reduced to 10 ppm by feeding sulphuric acid, which increased free CO_2 to 8 ppm and reduced pH value to 6.5. About half of the bicarbonate alkalinity was changed to the normal carbonate and the pH value was increased to 8.5.

While making these tests the exhaust-steam pressure was approximately 12 to 13 lb g, and temperature of the deaerated water was approximately 245 F, which corresponds to the temperature of saturated steam at the pressure within the heater.

At all times the deaerated water had zero oxygen to the second decimal place or less than 0.005 cc per liter as determined by the Schwartz-Gurney modification of the Winkler test.

Sulphite Treatment

It is believed that, with a pH value of 8.8 and the oxygen near absolute zero by this method of deaeration, the high-pressure heater, feedlines and boilers would be safe from corrosion without further treatment. However, as an additional precaution, the deaerated water is treated with 2 epm/50 of sodium sulphite.

Water leaving the deaerator and boiler water is regularly tested for sodium sulphite and as nearly as can be determined the amount found in the water by these tests is equal to the amount added.

The high-pressure boilers have now been in operation two years and are satisfactorily free from scale and corrosion. Total solids in the boiler are kept at 2000 to 2500 ppm and steam leaving the boilers has less than 1 ppm of solids as determined by conductivity tests. The deaerating heater has not been out of service nor opened for inspection since it was first put into service. Oxygen and free CO_2 are removed effectively as shown by Table II. No difficulties have been experienced in the operation of the water-treating equipment.

Experience With a Reversed-Cycle Heating System

One of the largest and most complete reversed-refrigeration heating installations has been in operation for more than a year in the Administration and Service Building of the United Illuminating Co, New Haven, Conn. This article briefly describes the equipment and presents data on its operation

▶ THE REVERSED-CYCLE heating installation in the new Administration and Service Building of the United Illuminating Co, New Haven, Conn., is noteworthy not only for its size and completeness but for the fact that it is the only installation of this kind in the United States in an area where winter weather conditions are severe.

The basic principle of reversed-cycle heating is simple. In an ordinary refrigeration system, heat is absorbed, at low temperature, in the evaporator and rejected to the cooling water in the condenser, at considerably higher temperature. Application of mechanical energy in the compressor is necessary to lift this heat from the low evaporator temperature to the higher condenser temperature. The amount of heat rejected to the condenser is equal to the heat absorbed in the evaporator plus heat equivalent of the energy supplied at the compressor. The "efficiency" of such a refrigeration system is measured by the "coefficient of performance"—the heat absorbed in the evaporator divided by heat equivalent of mechanical work done at the compressor.

"Reversed" Arrangement

The same equipment can be used for heating as well as for cooling. In this "reversed" arrangement, mechanical energy supplied to the compressor is used to convert low-level heat from some convenient source into high-level heat at the condenser. Here the useful output is the heat given up by the condenser and the coefficient of performance is the useful heat divided by the heat equivalent of the compressor work.

In the United Illuminating Co installation an unlimited source of underground water, at 55 F throughout the year, is used. In summer, this water passes through the evaporators of the refrigeration system, where it is chilled to the temperature necessary for summer air conditioning. The chilled water flows through the air-cooling equipment in the building and then through the refrigeration condensers where it absorbs heat taken from it in the evaporators. After passage through the condensers, the water goes either to the sewers or back to the wells (see Fig. 1).

In winter, well water flows directly through the evaporators to the sewer or back to the wells. Heat absorbed from the well water is pumped by the refrigeration compressors, at a higher temperature, to water flowing through

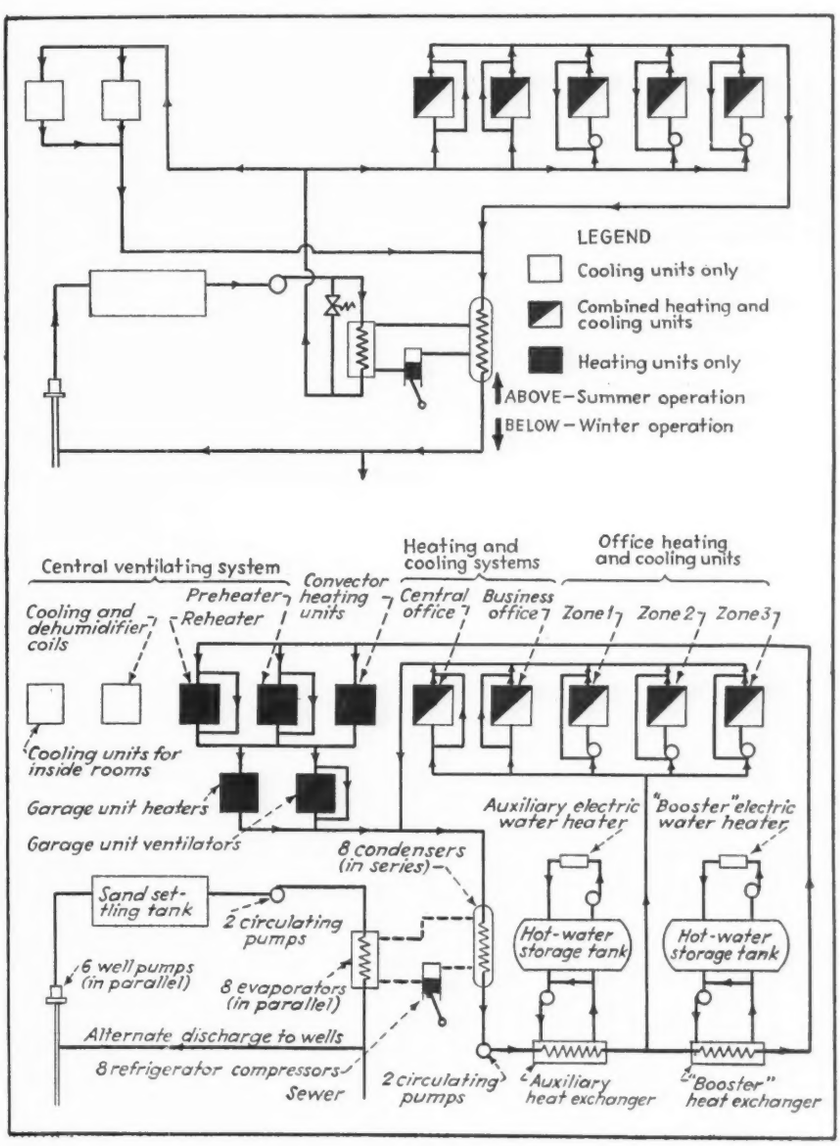


Fig. 1—Simplified diagram shows winter and summer operation

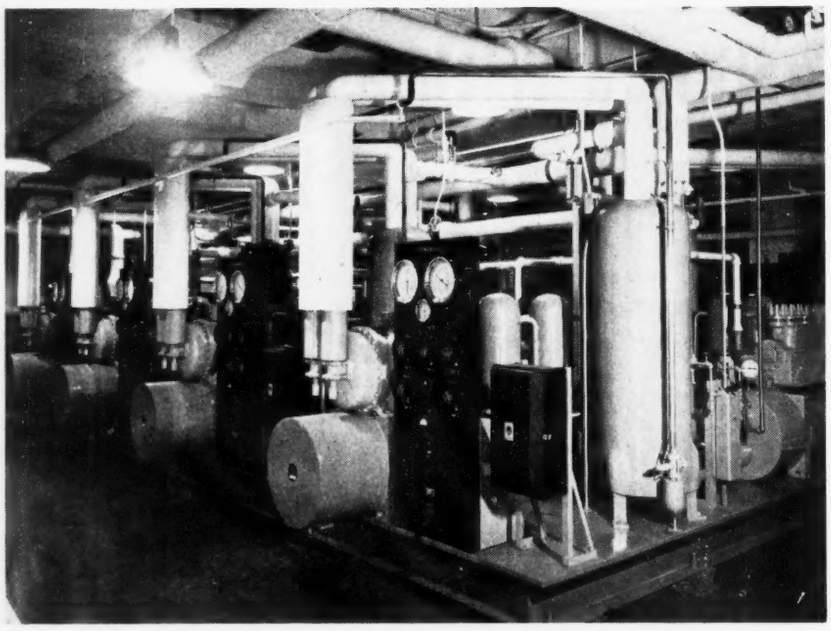


Fig. 2—Refrigeration equipment consists of eight completely independent condensing units, mounted in two rows of four machines on a single structural-steel sub-base

the condensers; this warmed water circulates to the heating surfaces throughout the building.

The fact that the basement and two-thirds of the ground floor are used for garage and service facilities while the rest of the ground floor plus the second and third floor contain the offices of the company, dictated the layout of the heating and cooling equipment. A central air-conditioning system, handling outside air only, services the office spaces; air is cooled and dehumidified in summer and humidified and heated to room temperature in winter. Supplementary local heating and cooling units are installed under windows, in small offices; large offices and commercial areas have supplementary central fan-and-coil units. Interior rooms are fitted with supplementary units for cooling only and rooms on the north side, with large winter losses and small summer gains, are fitted with convectors for winter operation only. Convectors also heat hallways, stairways, toilets and small offices without air conditioning; unit heaters supply large toilets where exhaust fans cause high heat losses.

Special Problem

The garage areas presented a special problem since times of heavy traffic, when ventilation is required, occur only in the morning and evening, when service trucks leave and return. Peak demand amounts to almost one-third of the total heating load but the overall heating load of the garage is small. Unit heaters and unit ventilators serve the garage areas, with the entire space divided into three sections, each equipped with exhaust fan and collecting ducts, and outside-air supply fans and heating coils of the unit type.

The system of distribution piping for hot and cold water is designed to serve these various heating and cooling requirements with maximum economy. To avoid a large unbalance in heating and cooling loads on the refrigeration equipment, the reversed-cycle system is arranged to meet all heating requirements for outside temperatures as low as 20 F. Additional heating required for lower temperatures comes from an auxiliary booster electric water-heating unit. This consists of a 480-kw heater, a 7000-gal storage tank, heat exchanger, and circulating pumps, arranged as shown in Fig. 1. Under time-clock control, the heater operates off peak, low-temperature water being drawn from the bottom of the tank by a local circulating pump and heated water being returned to the top. When "boosting" is necessary, a pump draws 350-F water from the top of the tank, forcing it through the heat exchanger and returning it cooled to the bottom of the tank. Cooling the contents of the tank from 350 to 150 F will handle maximum booster requirements for a full day. A duplicate heater and tank hookup is provided and is piped to permit operation as a booster or as a substitute for the reversed-cycle heating.

Booster heating is required only for the heating units; water for the combined heating and cooling units comes from the condensers directly. Because of slightly lower temperatures maintained in the garage areas, these heating surfaces are connected in series with the air-conditioning system heaters and the convectors, thus reducing the total water flow and lowering the temperature of water returning to the condensers (see Fig. 1). Bypasses around the unit ventilators and the air-conditioning system heaters return heated water directly to the condensers when the coils are not in operation.

Heating and cooling units in the individual offices are grouped in three zones with separate supplies and local pumps; the central fan and coil systems for the business office and the central office are also on separate circuits. The bypass arrangement on the individual office circuits permit the pumps to draw from either the general heating system or from the recirculating system, under control of a zone thermostat. Bypasses on the general-office units return excess water to the condensers directly.

At the design condition of 20 F, the reversed-cycle system can raise the condenser-water temperature from 108 to 124 F; thus all equipment not connected to the booster circuit must be capable of maintaining desired conditions when supplied with 124-F water. A compensating outdoor thermostat controls operation of refrigeration units to maintain lower water temperature as outdoor temperature rises above 20 F. When heating-coil bypasses return water directly to the condensers and thus increase inlet temperature above 108 F, the thermostat control cuts out refrigerating units if the outside temperature is above 20 F or increases the temperature off the condensers as high as 138 F when outside temperature is below 20 F.

Summer Cooling

Fig. 1 also shows the arrangement for summer cooling. Changeover to summer operation is effected by a single automatic control switch which reverses the action of thermostats controlling the heating and cooling units and changes control of compressor operation from the condenser-exit thermostat to the evaporator-exit thermostat, both of which are compensated from the outdoor thermostat. A water bypass around the evaporators permits full water flow operation when refrigeration is not required.

Refrigerating equipment consists of eight completely independent condensing units without interconnection of refrigerant piping. This permits removal of any unit for inspection or maintenance, without interfering with the operation of the other units in any way.

Each unit consists of a Westinghouse vertical, 8-cyl compressor (with driving motor mounted on the compressor crankshaft and hermetically sealed in the compressor casting), 2-pass horizontal shell-and-tube condensers, and Westinghouse vertical shell-and-coil water-chilling units. The eight condensing units are mounted on a single structural-steel base supported by Korfund adjustable spring mountings. Compressors, condensers and water chillers bolt directly to the steel frame. All piping between the refrigeration equipment mounted on the base and the building piping system carries flexible connections to prevent transmission of noise and vibration.

Dual high-pressure cutouts, low-pressure and low-temperature refrigerant cutouts, low-water-temperature cutouts and oil-failure cutouts on each unit protect against breakdown. By a rotary sequence switch the operator can change the starting and stopping sequence of the compressors under the automatic control, to insure equal distribution of work between the units and thus to equalize running time. A meter showing operating hours on each machine guides the operator in setting up the sequence program.

Water-Cooling Circuit

The eight water-chilling units (evaporators) are connected in parallel; they each cool 50 gpm from 55 to 40 F under guaranteed conditions. The condensers, in series, raise the water temperature in steps. With inlet water at 107.8 F they are guaranteed to deliver 124-F water, if coolers are supplied 400 gpm (total) of 55-F water. Under these conditions the plant will deliver 3,465,000 Btu per hr with a power input of 316.7 kw to the compressors.

Six wells tap the underground water supply; four wells supply enough water for maximum requirements. Four float switches set at different levels in the settling tank cut in the pumps as required. The operator can vary the sequence of well operation by means of a jacking arrangement, which permits connection of any one of the six well pumps to any one of the four float switches. Two circulating pumps, arranged in parallel and each capable of supplying the 400 gpm required, take suction from the 6000-gal settling tank and discharge to the evaporators. Water returning from the evaporators in winter or from the condenser in summer may be discharged to the sewer or to the wells not in operation.

During January 1940, the building was heated by the direct-heating equipment. During February, March and April of that year, the reversed-cycle system was tried out for short periods. On May 12, 1940, tests were begun on the cooling cycle and the system was operated intermittently for heating and cooling until June 3. The cooling cycle continued in use from June 3 to October 15 and from this date until the end of the heating season all the heat used in the building was produced by the compressor equipment. Power supply for this heating and cooling equipment comes from a distribution substation across the street from the building and is separately metered. Although no special tests were made, it is possible to get a fairly accurate picture of the performance of this equipment from the operating records.

The record shows that for January and February of 1940, kwhr consumption was 269,694 and 194,263; the degree days registered at the local weather bureau were 1304 and 988, respectively. During January all heating was direct and during February it was about 92.5% direct so that these two months give a good picture of performance for the direct-heating system. The kwhr consumption per degree day amounts to 208 for January and 197 for February. Allowing for the small amount of reversed-cycle heating in February, an average of about 205 kwhr per degree day may be figured.

For the corresponding months of 1941, using all reversed-cycle heating, the kwhr are 99,400 and 80,300, the degree-days are 1184 and 985, and the kwhr per degree-day are 84 and 82, respectively. This indicates a coefficient of performance of approximately 2.5. It must be remembered that the input figures include pumps and auxiliaries that operate with a coefficient of performance of 1; this explains the fact that actual coefficient of performance is lower than might be expected from theoretical or design considerations.

Properly segregated investment costs are not available to determine the economic justification for this installation. All installations made in climates where winter weather is severe suffer from the handicap of heavy heating loads which

(*Continued on page* 136)

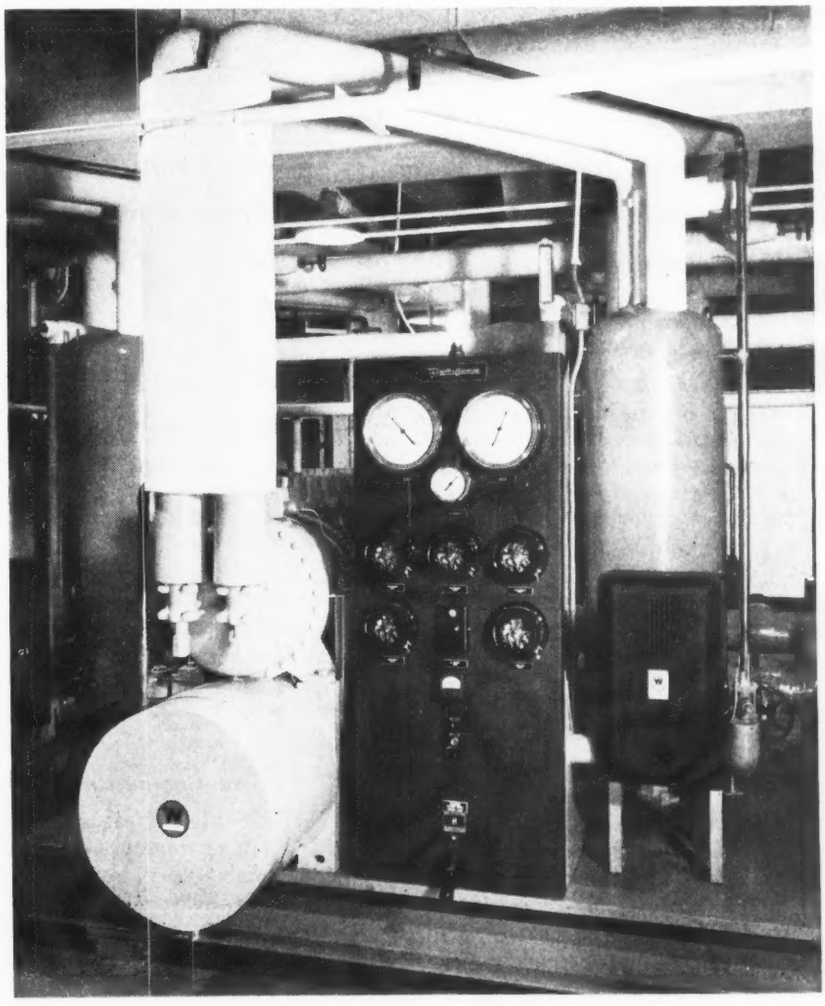
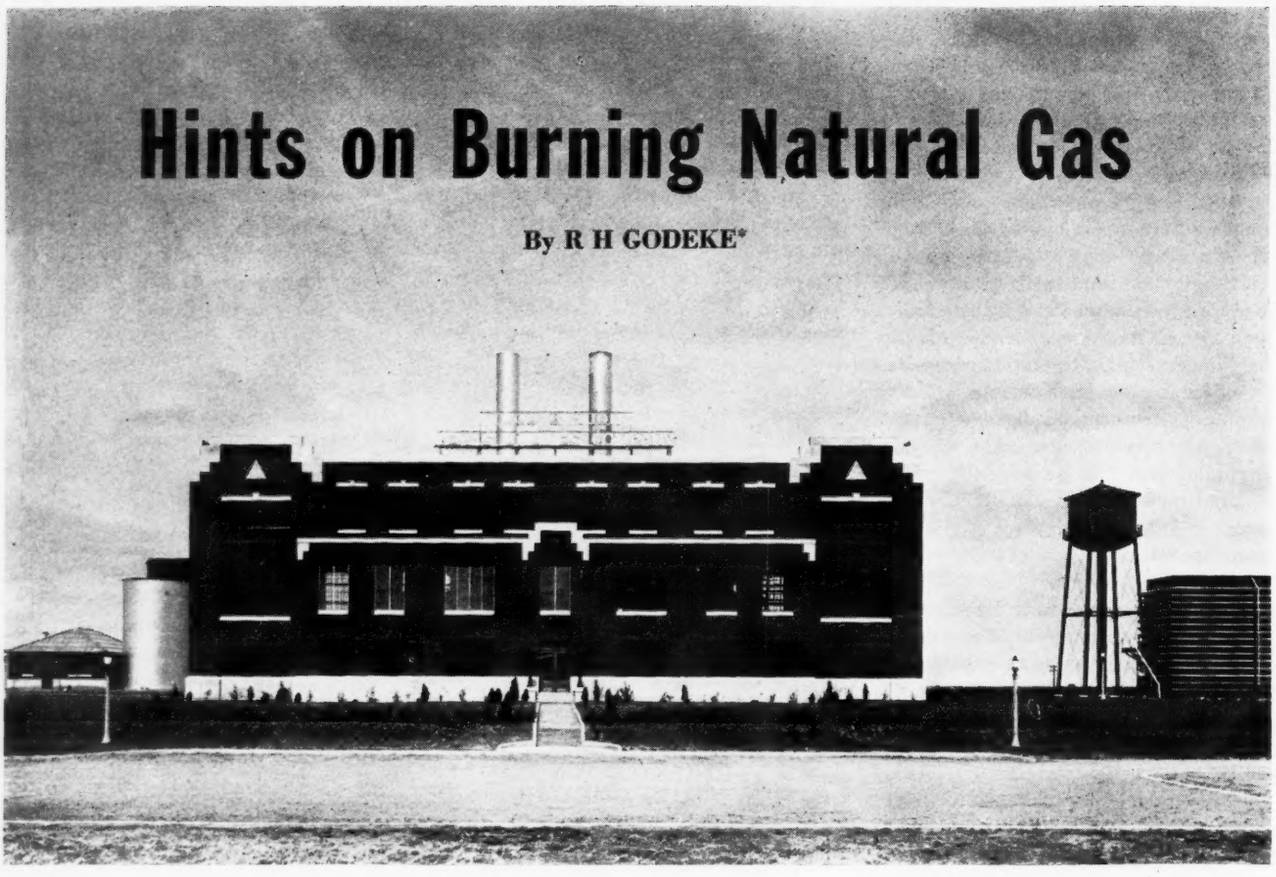


Fig. 3—Typical instrument and switch panel for one of the eight condensing units; note operating-hour meter just above pushbutton station in lower part of panel

Hints on Burning Natural Gas

By R H GODEKE*



Tests at Tuco Station of Texas-New Mexico Utilities indicate better results from increased excess air. Natural gas requires firing technique different from oil or coal

Fig. 1—Tuco Station at Abernathy, Texas, contains four boilers supplying two 7500-kw turbines at 260 lb. Tests were run on two older cross-drum units to determine best excess-air ratio

► MOST ARTICLES ON COMBUSTION spare only a few words to tell how to burn natural gas because operators of coal-fired plants generally consider gas firing much too simple for lengthy consideration. Getting top efficiency from gas, however, requires certain changes from coal or oil practice, illustrated here by the results of simple tests which should be carried out by all gas-fired plants.

Boiler-efficiency curves show that best performance is obtained in the range of loads between one-quarter and three-quarters rated capacity. Within this range efficiency is nearly constant and, where a sufficient number of boilers are available, most economical fuel performance is obtained when all units carry equal or proportionate shares of the total load with none too lightly or too heavily loaded.

Natural gas derives its heating value from two major constituents, carbon and hydrogen. For a given gas source, the chemical and physical properties remain reasonably uniform the year around. Table I (page 79) gives a typical ultimate analysis of West Texas gas.

The tests described in this article were conducted by the writer at the Tuco Station of the Texas-New Mexico Utilities Co, Abernathy, Texas. Three 7500-sq ft, 60,000-lb-per-hr boilers supply steam at 260 lb to two 7500-kw turbine-generators. Two of the steam-generating units are cross-drum, water-tube boilers, one installed in 1930 and the other a year or so later. The third is a Stirling 2-drum unit, put in service in 1938. Tests to determine best excess-air ratio were run on the two older boilers.

Perfect Combustion

Ordinary orsat liquid reagents absorb the H_2O resulting from the combustion of the high percentage of hydrogen contained in natural gas; thus the highest CO_2 possible (dry analysis) is about 11.9% for perfect combustion with zero excess air. During three months of testing, orsat readings ranged between 9.7% and 10.4% CO_2, corresponding to excess air ratios from 132 to 123%.

Orsat apparatus does not show small percentages of carbon monoxide (CO) accurately. Nevertheless, readings were taken as best possible and tabulated according to the observed amounts, no matter how small the noticeable change in volume of the sample after passing through the cuprous-chloride solution and rewashing with potassium-hydroxide solution. The sample picks up a certain amount of hydrochloric-acid vapor from the cuprous chloride solution, and has to be rewashed in the potassium hydroxide cell. Amount of hydrochloric acid absorbed varies with the age of the cuprous chloride solution.

Actual heating values of methane and ethane are somewhat lower than would be expected from calculating the heat liberation of carbon and hydrogen separately. Instead of the 26,405 Btu per lb methane (CH_4) would produce if carbon and hydrogen were not already combined, calorimeter results show

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about 23,850 Btu per lb. Likewise ethane (C_2H_6) has an actual heating value around 22,230 instead of the theoretical 24,032.

About 41% of the heating value of methane is due to carbon burning to CO_2; the corresponding value for ethane is 48%. Other heat is supplied by hydrogen burning to H_2O. For the gas analysis of Table I, with complete combustion and no excess air, 43% of the heat is developed by burning carbon.

Proper Excess Air

Determining the proper excess-air ratio requires a balance between the loss due to incomplete combustion (CO) and increased stack loss due to the larger quantity of air heated to stack temperature. By plotting losses due to incomplete combustion and excess-air against the percent of theoretical air requirements on a single sheet as in Fig. 3, the sum of the two losses may be plotted to determine what air-fuel ratio gives highest actual efficiency. For the method of calculation of both losses, refer to POWER, December, 1940, pages 58 to 61.

The curve of Fig. 3 for total losses indicates that efficiency is improved for the conditions at Tuco by increasing excess-air ratio above 120% or decreasing the ratio below this value. Operation at very low excess-air ratios, however, involves the possibility of flames reaching the superheater, increased furnace maintenance and improper position of the fire in respect to the boiler design resulting in poor heat exchange between gas and water. Thus, desirable operating range is near 132% where the loss due to CO is practically or entirely eliminated.

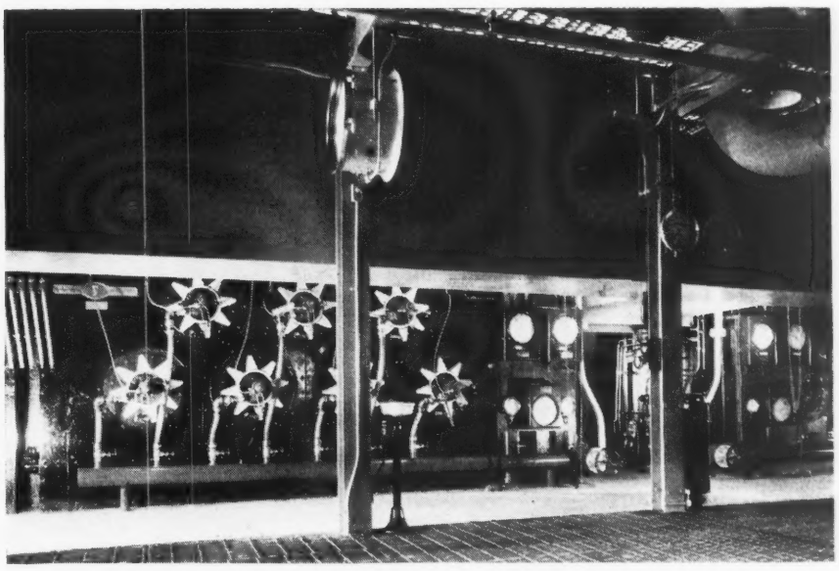


Fig. 2—Burner arrangement for gas firing illustrates simplicity of connections

There is no further saving to be made by increasing excess-air ratio above the point at which CO is negligible and, under conditions similar to Tuco's, best operation is obtained with just enough air to kill the CO. The 32% excess air required to accomplish this at Tuco seems high in comparison with data collected in other plants, but improved efficiency in actual operation was obtained by increasing the air ratio.

Another condition peculiar to natural gas was improved by the increased air quantity. The large percentage of hydrogen in natural gas forms considerable water vapor in the flue gas which condenses on air preheater elements if

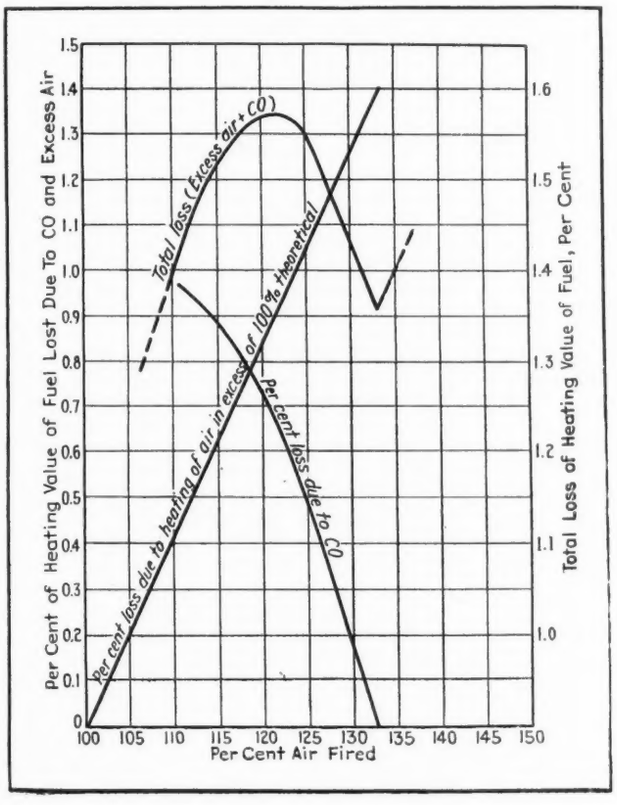


Fig. 3—Total combustion loss resulting from excess air and CO indicates better performance in this case if excess-air ratio is held close to 130%

TABLE I—ULTIMATE ANALYSIS OF WEST TEXAS NATURAL GAS

	By Volume	By Weight
Methane — CH_4	75.0%	62.18%
Ethane — C_2H_6	13.8	21.45
Carbon dioxide — CO_2	0.1	0.23
Oxygen — O_2	0.1	0.17
Nitrogen — N_2	11.0	15.97
	100.0%	100.00%

Heat content at 30-in. barometer and 60 F = 1023 Btu per cu ft
Specific gravity = 0.765 referred to air as 1.0

TABLE II—TYPICAL ORSAT ANALYSES

Excess Air	17.0%	23.6%	26.9%	30.3%	32.5%
CO_2	10.8	10.4	10.2	9.9	9.7
O_2	3.6	4.2	4.7	5.2	5.5
CO	0.3	0.2	0.1	0.05	0.0
N_2	85.3	85.2	85.0	84.85	84.8

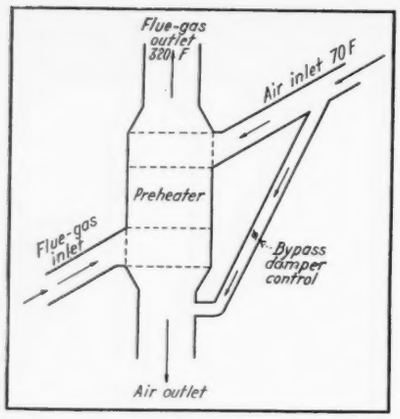


Fig. 4—Preheater-bypass arrangement allows control of flue-gas outlet temperature to avoid condensation

temperature falls below the dew point. Moisture so formed results in scale formation or corrosion or both.

The preheaters at Tuco are equipped with an air bypass, Fig. 4, with damper control to regulate amount of air going through the preheater. A temperature of 320 F measured at the center of the preheater-outlet passage eliminates all condensation and the temperature has been regulated to this value for several years without corrosion. At high boiler output, of course, with the damper completely closed, temperature rises above the set value.

A temperature of 320 F in the center of the gas stream was determined after months of experimenting with strategically located "water buckets" to discover the condensation limit. The calculated dew point for 132% air was found to be 123 F. However, measurement of conditions at the metal surface of the preheater is difficult and some allowance was felt necessary for worst conditions of operation.

There is bound to be heat wasted at better conditions of operation by holding a higher temperature than necessary at the preheater outlet; the possibility should not be overlooked of reducing flue-gas loss by careful and extensive checking of minimum temperature that will not produce condensation. Installation of thermocouples directly on the preheater surface might be one solution to allow operation at a lower average temperature than 320 F, but such thermocouples have not yet been installed.

Simple Calculation

Constant flue-gas outlet temperature simplifies the calculation of the excess-air loss and results in the straight line shown in Fig. 3. The large amount of excess air needed to eliminate CO gave rise to many theories as to what caused such extreme results. The orsat sample was drawn through a long pipe inserted in the flue and a more comprehensive piping arrangement would have given more confidence in the true representativeness of the sample. Burner adjustment could account for some incomplete combustion. Some setting leakage could have been present or leaky baffles might have bypassed part of the gas before complete combustion of the CO had taken place. However, no noticeable drop in superheated steam temperature was observed nor was there indication of excessive soot formation.

As a check on the orsat readings, the tabulated values were plotted on a check chart, Fig. 5, taken from POWER, Jan, 1935. The calculated value of "Z" for natural gas, not given on the original chart, was calculated as 0.76 and all readings intersected satisfactorily in a common point. This seemed logical as the small percentage of CO, below 0.3%, represents only a very small distance on the chart. However, the common point of intersection of the several analyses plotted is considerably above the line for zero CO.

It is an asset to any plant to have determined and established most efficient operating conditions. The test results at Tuco indicated a high percentage of excess air; other cases should be considered separately and the material presented here is intended as an indication of one method and one series of tests. Curves like Fig. 3 and checks on orsat readings such as afforded by Fig. 5 give the operating personnel confidence and satisfaction that they are getting all possible Btu's out of fuel fired.

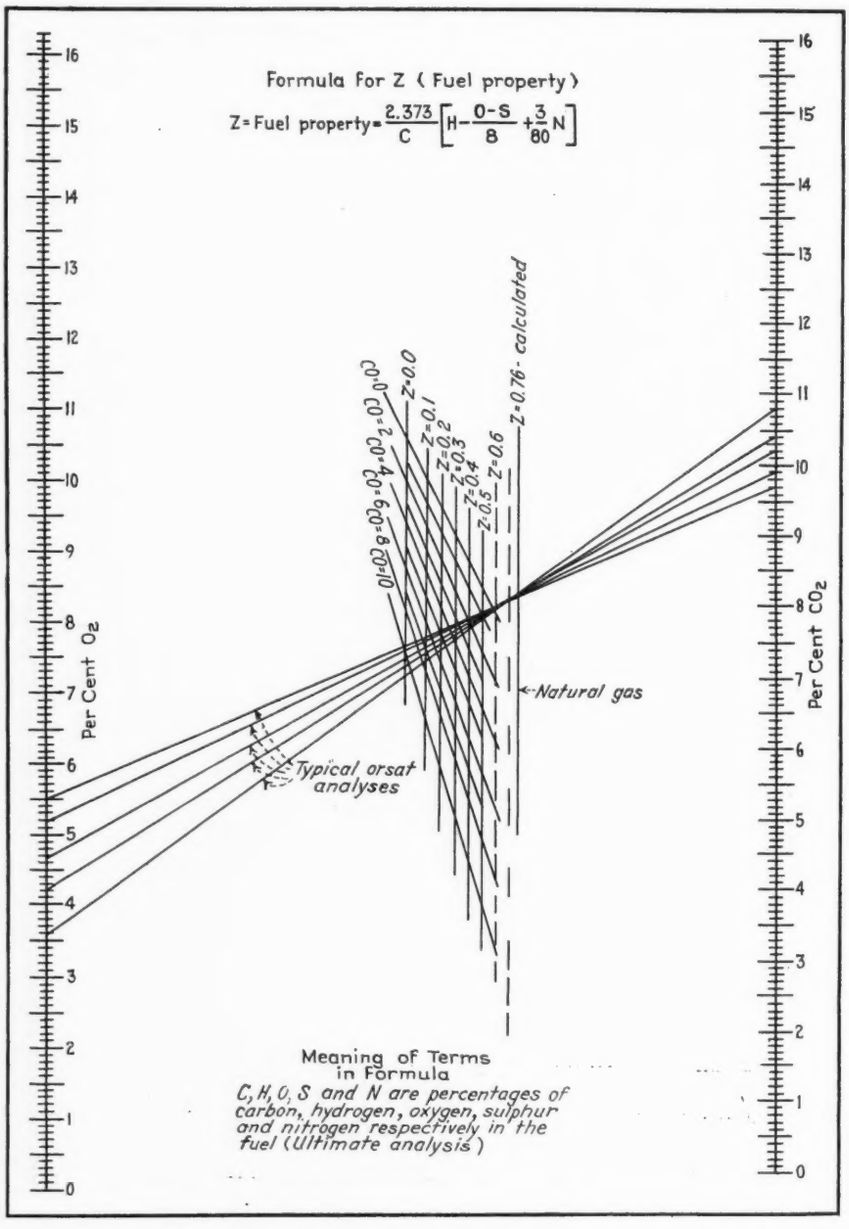
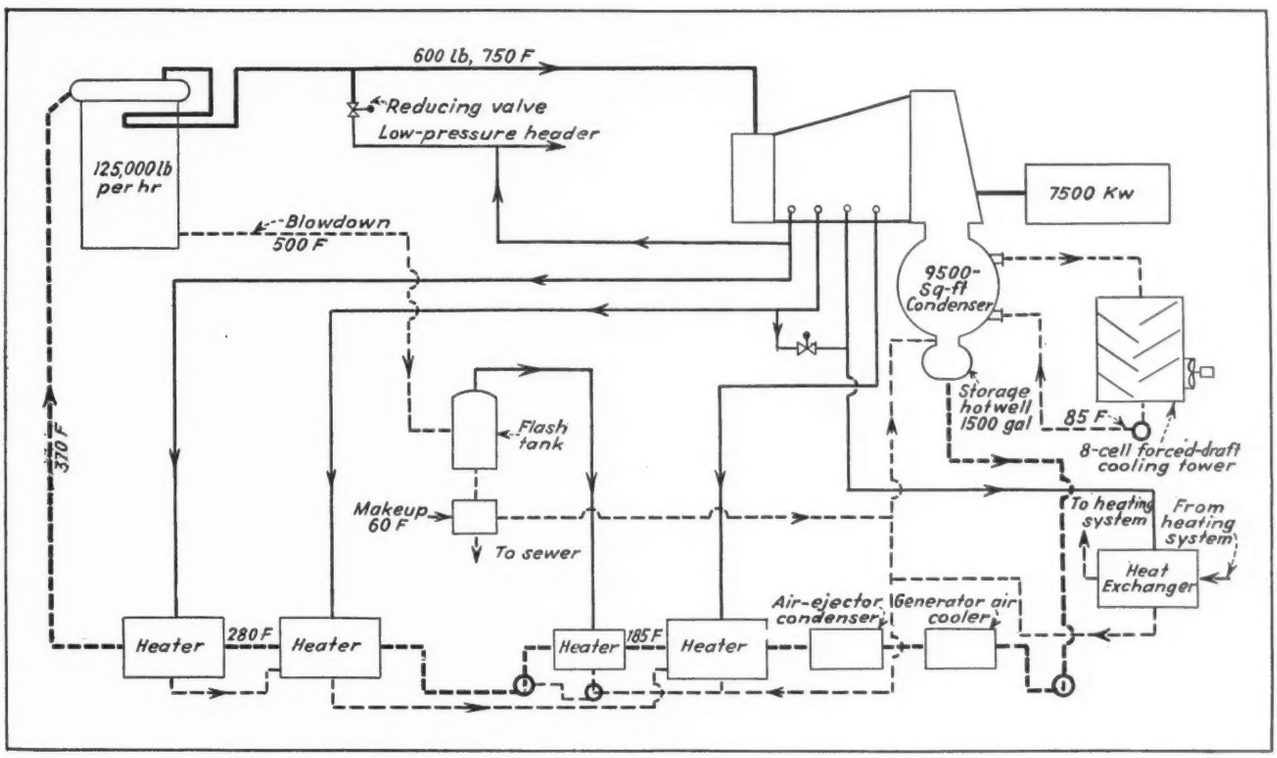


Fig. 5—POWER Data Sheet No. 28 checked orsat readings

Multi-Purpose Top

New 125,000-lb-per-hr, dry-bottom boiler supplies 7500-kw condensing topping turbine arranged for bleed to central-heating system and older low-pressure units as well as to three stages of regenerative feed heating



► LOAD GROWTH in the western part of the state has given the go-ahead signal for rapid expansion of Boone Station, Iowa Electric Light & Power Co, Boone, Iowa. Construction is now under way for a 7500-kw topping unit, with another projected for 1942. Present capacity is 6500 kw; when additions are completed, the station will be able to turn out 21,500 kw.

The dry-bottom, water-cooled, 125,000-lb-per-hr boiler will burn pulverized Iowa coal. The turbine-generator, rated 7500-kw, 2400-volts, 3-phase, 60-cycle at 70% pf, will be able to generate 9375 kw at 83% pf. Of the four bleed points, three are used to heat feedwater; the other supplies a central-heating system at 5 lb g. The first bleed point is also arranged to supply steam to existing units.

Exhaust goes to a 2-pass, 9500-sq ft condenser, welded to and part of the turbine casing to eliminate usual expansion joints and spring supports. The 1500-gal condenser hotwell also serves as the station surge tank. Shell of the condenser is of welded copper-bearing steel.

Three Cycles

At normal operation, the turbine will pass through its throttle approximately 90,000 lb of steam per hr. When heating central-system water, this flow increases to about 104,000 lb per hr, and when the unit operates semi-topping, flow is about 126,000 lb per hr.

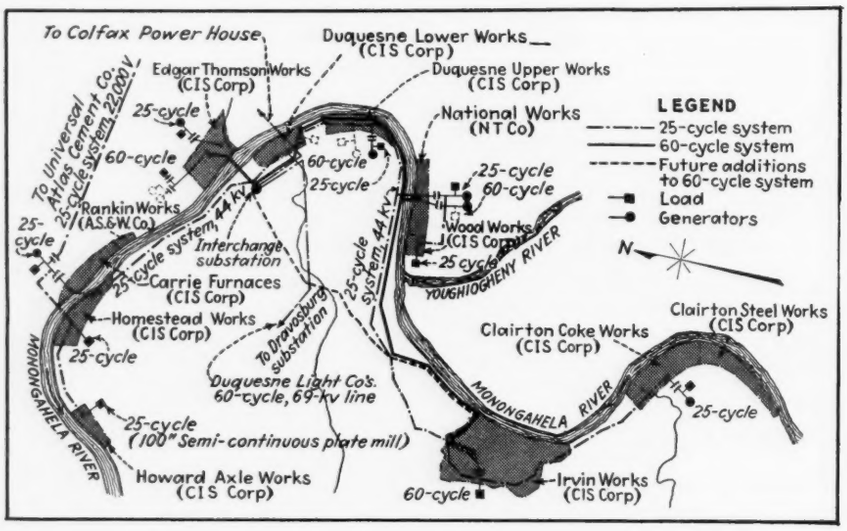
The building, of fireproof concrete, structural-steel and brick construction, will provide space for the second 7500-kw turbine. Present side-track facilities are being extended to a new coal pocket or track hopper for unloading dump-bottom cars. Handling equipment will include coal crusher, magnetic pulley, conveyors and 400-ton overhead storage bunkers. Coal will feed from the bunkers through two automatic scales to two pulverizers in the boiler-room basement.

A cooling tower (eight cells, each cell with its own induced-draft equipment) will supply condenser cooling water. Capacity will be 130,000 lb of steam loading; the unit will be able to cool the water to 85 F at 37 F wet bulb. Provision will be made for adding another tower if future demands require it.

Two boiler-feed pumps are each capable of delivering 300 gpm. One, motor-driven, will be operated the greater part of the time; the other, turbine-driven, will see service as an emergency and starting-up unit.

"Big Steel" Adds 40,000 Kva

Carnegie-Illinois Steel Corp, foreseeing heavy defense activity, installs a single-boiler, single-turbine plant at Rankin, Pa. Problem of handling possible enormous load swings and burning two dissimilar fuels, separately and in combination, produces a unique control system and air-heater-economizer bypass hookup

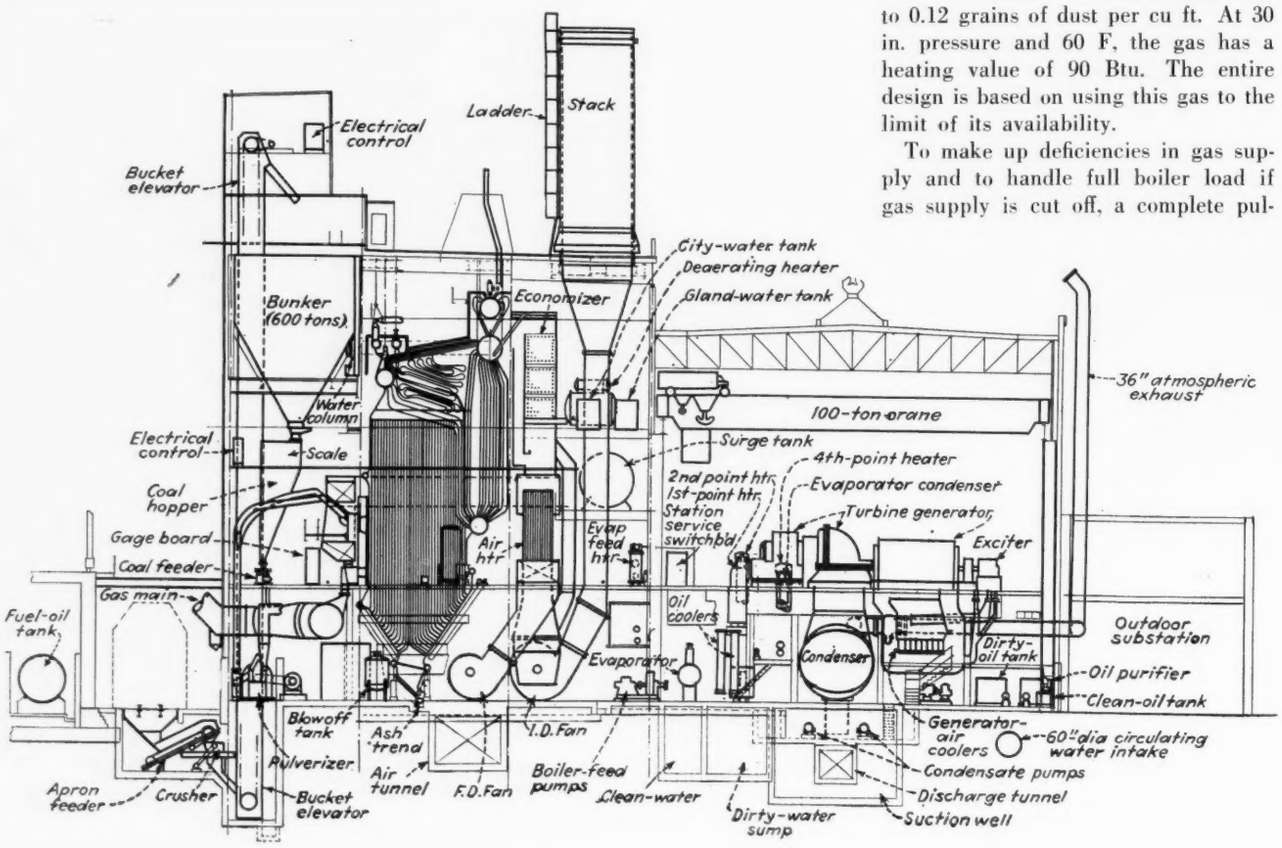


Carnegie-Illinois Steel Corp has just placed in operation its new No. 3 Power House at Carrie Furnaces, Rankin, Pa. This single-boiler, single-turbine plant adds 40,000 kva to the existing 120,000-kva, 25-cycle "Big Steel" network, serving mills in the Pittsburgh area.

Automatically compensated combustion control to maintain proper fuel-air ratios for any combination of the two fuels, blast-furnace gas and pulverized coal; drum-pressure regulation to give an accumulator action to meet potential enormous load swings, and an unusual preheater and economizer by-pass hookup to provide the flexibility needed under various fuel and load conditions make this a boiler house of unusual engineering interest.

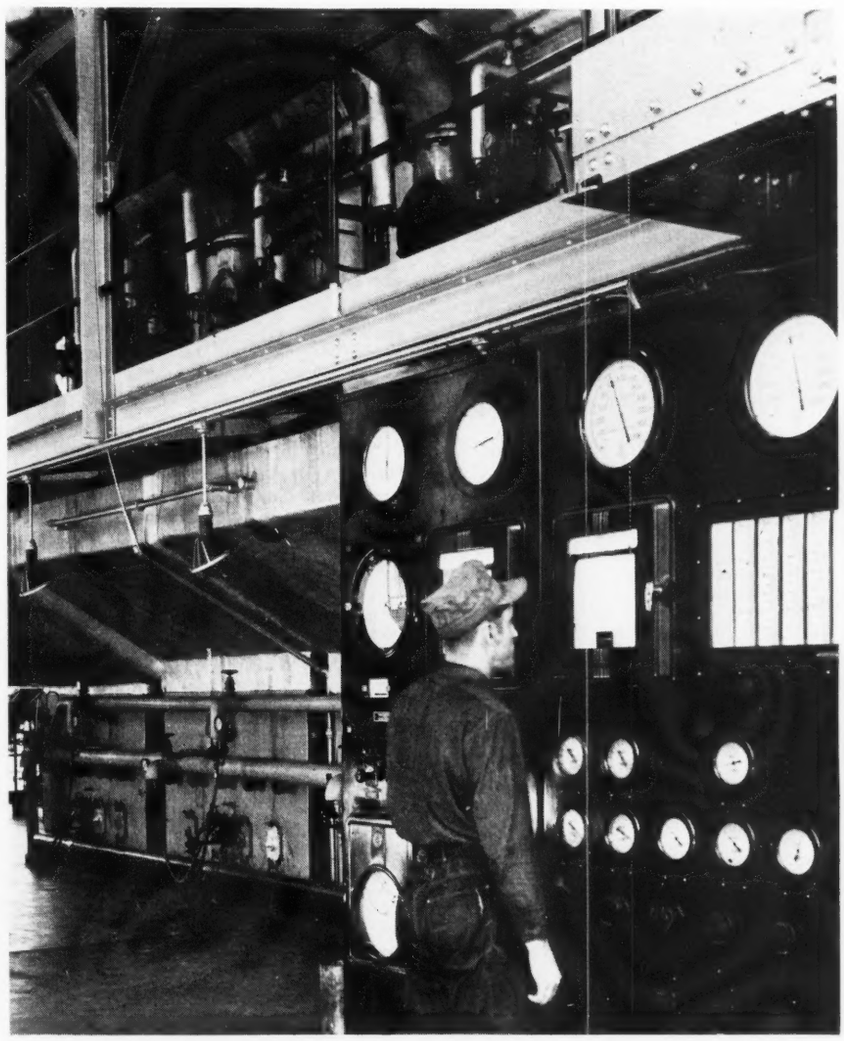
The plant cross-section shows the principal power equipment. The basic fuel, blast-furnace gas, comes to the power house through a new 8½-ft welded-steel main, 1500 ft long. This provides capacity for a final development five times the size of this first unit. The gas, cleaned at the furnaces by wet scrubbers, reaches the boilers in a saturated condition and may contain up to 0.12 grains of dust per cu ft. At 30 in. pressure and 60 F, the gas has a heating value of 90 Btu. The entire design is based on using this gas to the limit of its availability.

To make up deficiencies in gas supply and to handle full boiler load if gas supply is cut off, a complete pul-



verized-coal handling and firing system is provided, complete with track hopper, apron feeder, bucket elevator and 600-ton steel bunker. Each of the two duplex Atrita pulverizers, rated 23,000 lb per hr each, is fitted with two star-type coal feeders. A single shaft, connected by variable-speed drive to a constant-speed motor, powers each pair of feeders. A low-rating damper on each pulverizer discharge adjusts coal-air mixture to the pulverized-fuel burners.

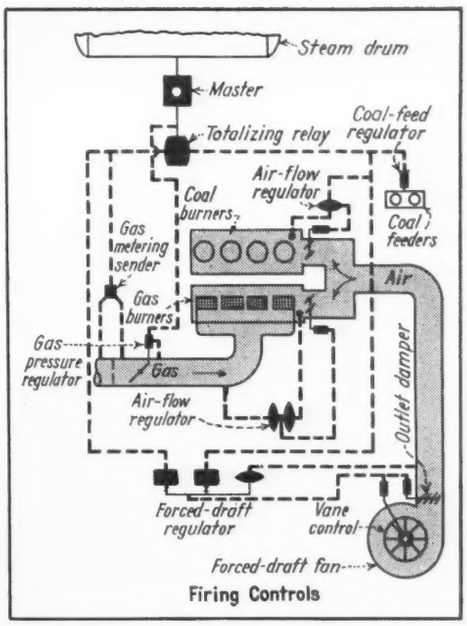
A combination oil-fired ignition and pilot-lighting system, designed for continuous operation, makes it possible to swing rapidly from one fuel to the other, and eliminates the possibility of losing ignition at low ratings with the lean blast-furnace gas. Pulverizers may run idle at full speed with feeders shut down, for quick availability in case gas supply is cut off.



The boiler is a 450,000-lb-per-hr, 4-drum unit, equipped with convection superheater, economizer and air preheater. Four gas burners, with single butterfly valve for controlling gas supply, are set in a horizontal row below a similar set of four horizontal-flare, forced-draft pulverized-coal burners. Both burner manifolds are fitted with dampers for regulating secondary-air supply.

For control of final steam temperature (750 F at 585-lb pressure), the superheater is divided into two sections; a portion of the steam from the first section flows through steam-cooling tubes, placed in the submerged boiler drum, before entering the second section. Regulating the amount of steam passing through the cooling tubes controls final temperature.

A concrete tunnel, fitted with intake louvres, supplies air to the two forced-draft fans, driven by constant-speed motors. Inlet vanes control fan output; each fan has louvre-outlet shutoff dampers. Induced-draft fans with vane control and both inlet and outlet dampers, draw gas from a common duct and discharge directly above into a 60-ft welded Cor-ten stack, 15 ft in diameter. The stack is lined with gunite (aluminite cement with a lightweight aggregate) on a reinforcing mesh.



Fuel control for combination burning is always something of a problem; the differing fuel-air ratios required by the two fuels must be properly maintained or loss of efficiency results. This problem becomes specially acute when the two fuels are as dissimilar as blast-furnace gas and coal. To meet this situation the ingenious control system shown above was developed.

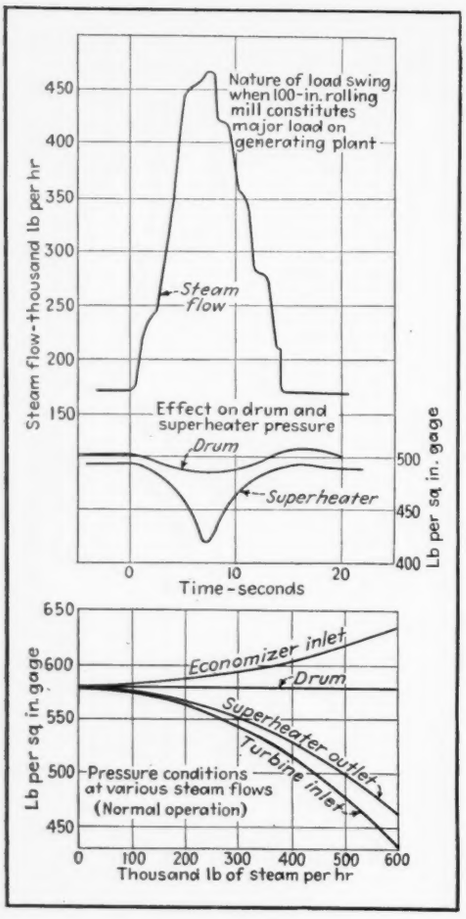
Operation of this control is briefly as follows: the master regulator reacts to steam pressure, sending a loading impulse to the gas-pressure regulator controlling operation of the butterfly valve. A low-limit regulator, not shown, prevents continued demand for gas from reducing gas pressure below a safe level, when gas supply is restricted.

To keep coal feeding in its proper supplementary relationship with the basic gas fuel, a gas-metering sender places a loading pressure on a totalizing relay, the loading pressure varying with amount of gas actually supplied. The master also places a loading pressure on the totalizing relay, corresponding to the total fuel requirements for maintaining steam pressure. The relay, in effect, subtracts the loading pressure from the gas-metering sender from that of the master, the difference corresponding to the need for coal to supplement the gas. The loading pressure from the totalizing relay actuates a regulator on the coal feeders, and another on the low-rating dampers.

To control the amount of air supplied, loading pressures from the gas-metering sender and the coal-feed regulator operate on the forced-draft regulator, signalling the relative amounts of gas and coal being burned. The regulator balances these two pressures, in accordance with their relative fuel-air

ratios, against forced-draft-duct pressure. The net loading pressure resulting actuates controllers on the vanes and outlet damper of the fans to give the highest forced-draft pressure required by either set of burners.

It is still necessary to divide the total air supply in accordance with the amounts of fuel being burned and the fuel-air ratios of each. This is accomplished, in each case, by using loading pressures from the fuel-supply controls as a measure of fuel being fed and pressure in the burner manifold as a measure of air supply. These two factors are balanced in regulators in which the setting of a movable fulcrum controls the fuel-air ratio to be maintained. These regulators adjust dampers in the burner manifolds. Individual burner adjustment is handled by manually adjusted dampers. A special steam-flow air-flow meter is arranged to compensate automatically for differences in air-fuel ratio when fuels are changed.


Nature of load swing when 100-in. rolling mill constitutes major load on generating plant
Steam flow
Steam flow-thousand lb per hr
Effect on drum and superheater pressure
Drum
Superheater
Lb per sq in. gage
Time-seconds
Economizer inlet
Drum
Superheater outlet
Turbine inlet
Pressure conditions at various steam flows (Normal operation)
Lb per sq in. gage
Thousand lb of steam per hr

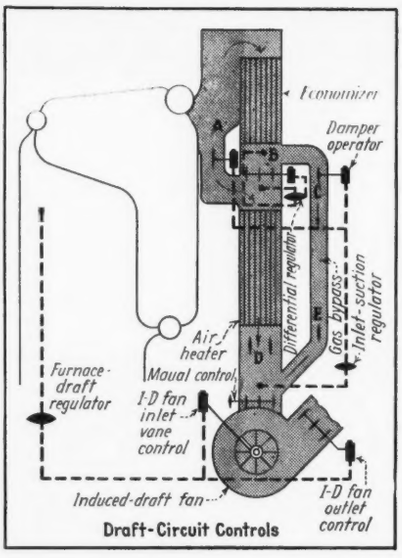
The load at this plant, under certain conditions, may be characterized by swings of enormous range; the cycle is repeated every minute. Thus, contrary to usual practice, the master regulator works from steam pressure in the drum. During periods of low business activity, when the mills on this power network are working at greatly reduced capacity, it may become desirable to carry all load on this new plant, which is the most efficient. Under these conditions, steel fabrication would probably be carried out in steps, which would mean that at times the great 100-in. plate mill might constitute the major load, resulting in the load swing pictured below.

If the combustion control were designed to follow this load swing closely, the result would be a series of "gulps" of fuel and air which would be physically impossible to coordinate with surges in steam demand. For this reason, the master regulator, through adjustable-dash-pot action, is adjusted to introduce a planned lag during which the demand for steam is met by accumulator action in the boiler drum. The purposely delayed response of the regulator to the extremely large and rapid swing permits drum pressure to drop, and part of the water in the drum flashes to meet steam demand.

Under normal conditions, the master follows ordinary load changes in the usual fashion. Tying the master to drum pressure rather than header pressure eliminates variables introduced by the superheater and connecting piping, and puts the control where it will be most effective for these special conditions. The effect of controlling by drum pressure can be seen in the diagram at the left, drawn for normal conditions.

Damper arrangement and control is a result of the wide variations in air and gas flows. Because of these variations, caused by the vastly different characteristics of the two fuels, a comprehensive system of dampers and bypass ducts was provided on the air heater and economizer to give the flexibility needed for maximum efficiency under these conditions.

For normal operation at partial loads when burning fuels in combination, and up to peak load on coal alone, gas passes through both economizer and air heater in the normal series arrangement. A furnace-pressure regulator controls the induced-draft-fan vanes and dampers to maintain desired furnace conditions. At peak loads with a combination of the fuels or with blast-furnace gas alone, the amount of flue gas to be handled becomes extremely large and the control is designed to put the economizer and air heater in parallel and open the bypass if necessary, to avoid exceeding the static-pressure limitations of the fans. As the pressure in the fan suction approaches the assigned limit, a fan-inlet suction regu-

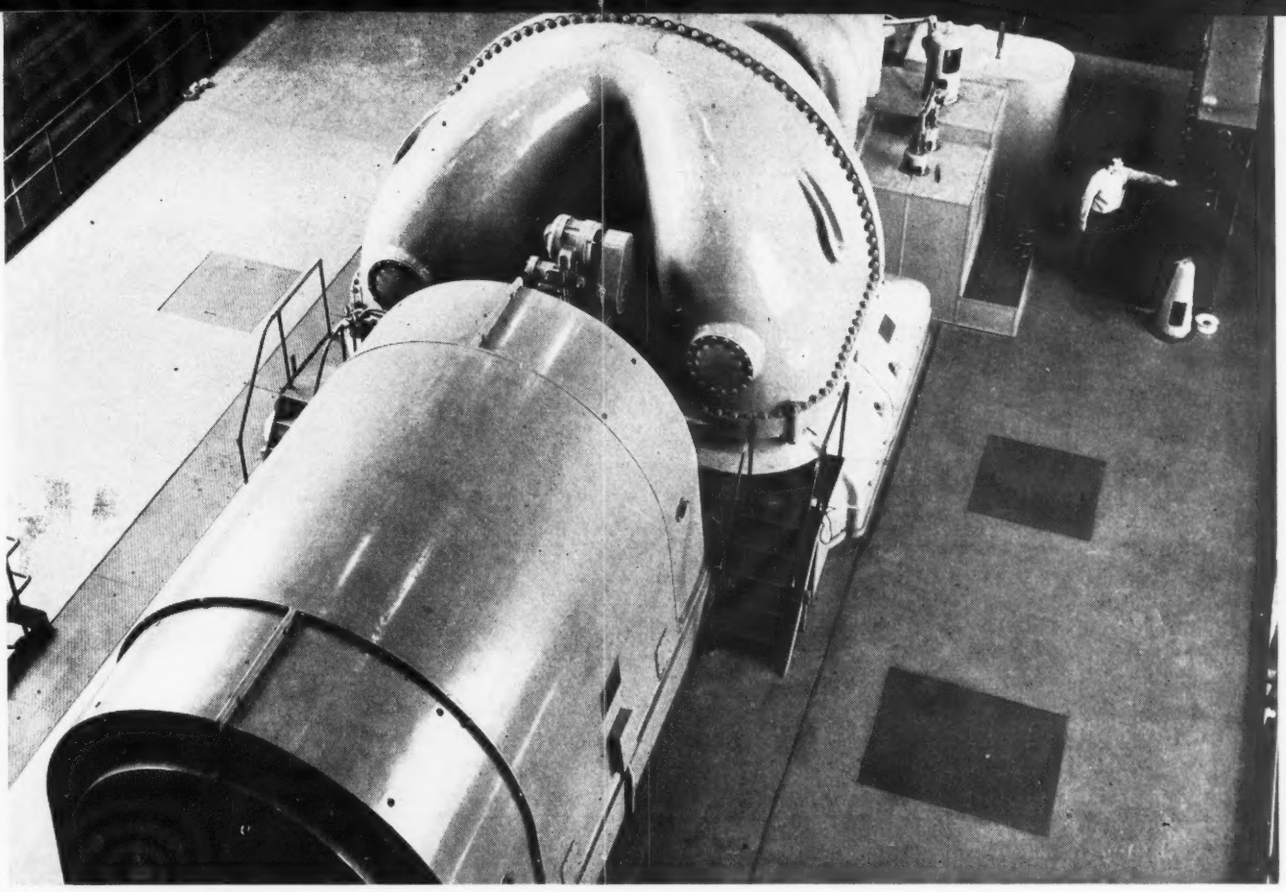


lator comes into action, opening dampers *A* and *C* to put the heat-recovery surfaces in parallel. The damper between the air heater and economizer (*B*) is controlled by a differential regulator and tends to close off as *A* and *C* open. When fan-inlet suction pressure is below the assigned limit, the suction regulator is inoperative and dampers *A* and *C* remain closed.

By remote manual operation of the dampers, other special conditions can be handled. For example, in starting up from cold, dampers are positioned to close off both air heater and economizer, all flue gas passing through the bypass. This avoids danger of steaming in the economizer and condensation in the heater. Because lack of preheated air may make combustion of blast-furnace gas unstable, it is preferable to bring the unit up to pressure on coal.

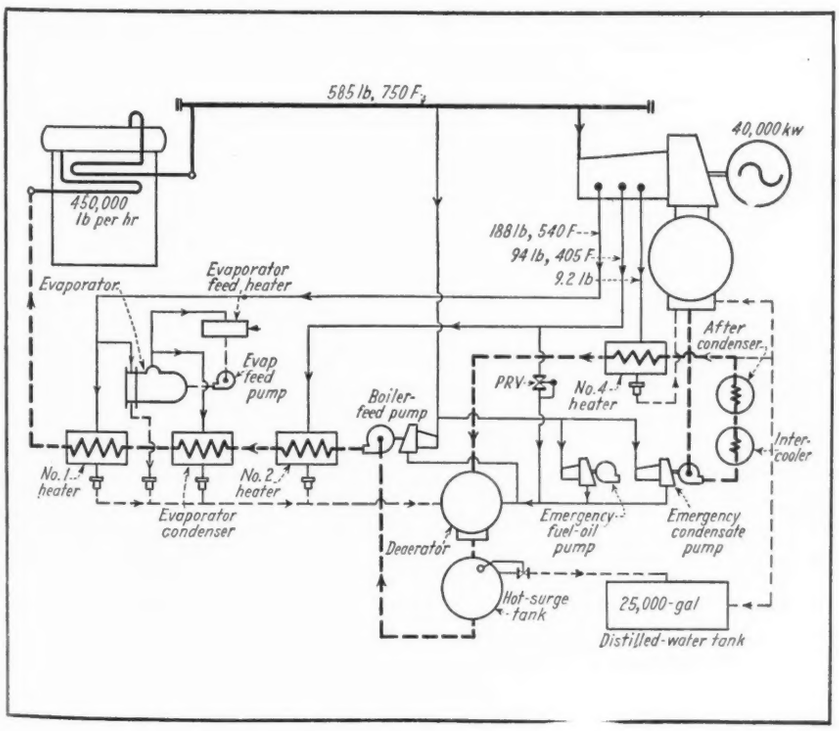
For low-load operation with blast-furnace gas, a maximum of flue gas should pass over the air heater, with none or only a small quantity flowing over the economizer. This gives maximum preheat temperature and thus better low-load combustion; bypassing the economizer keeps temperature of flue gas leaving the air heater above the dew-point for any steam load above 100,000 lb per hr.

The power-plant building is supported on steel H-piles. The approximately 350 10-in., 42-lb sections used were driven to rock 50 ft below the ground surface. This type of pile proved particularly suitable for the hard driving conditions encountered on this job, caused by a hard slag fill near the top of the ground and a layer of gravel just above the rock. The concrete substructure was carried to a level high enough above grade to protect against floods.



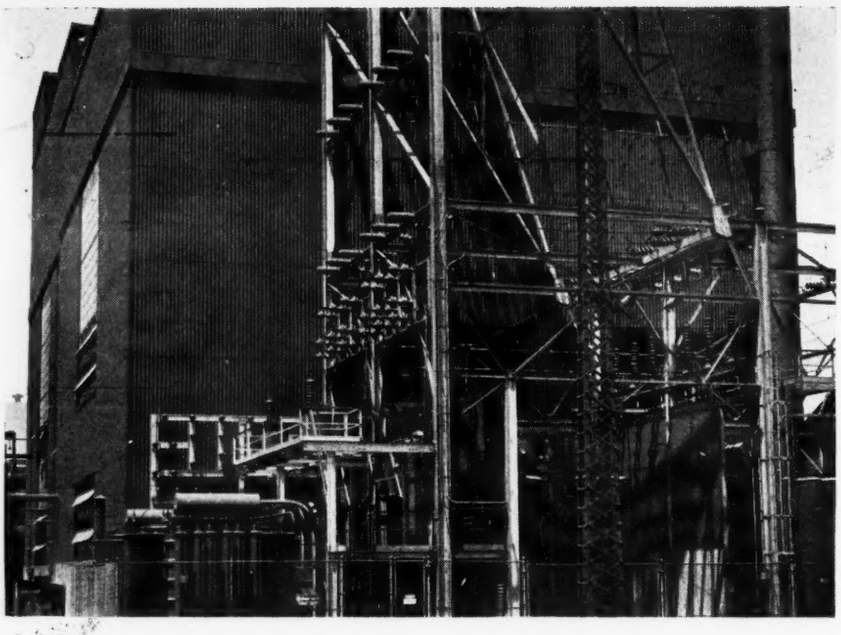
The single turbine, driving a 40,000-kva, 1500-rpm, 3-phase, 25-cycle, 13,800-volt generator, exhausts to a divided-waterbox surface condenser equipped with duplicate condensate pumps, one turbine- and one motor-driven. Circulating pumps are adjacent to an existing suction well at the north end of the existing intake tunnel, some 500 ft from the turbine room. 5-ft diameter cast-iron pipeline, good for 85,000 gpm, provides capacity for future condensers. River water from the circulating system supplies the tubular generator air and oil coolers of the new unit. All river water is lime treated against the acid condition resulting from the discharge of steel-mill wastes.

Circulating water from the new condenser discharges into a concrete tunnel running the length of the turbine room and designed to take the discharge of future condensers. An unusual feature is the driven discharge tunnel which runs 750 ft to the Monongahela River. This type of construction was necessary to avoid disturbing existing yard equipment and buildings in constant use. Starting at a concrete retaining wall at the river bank, the contractor drove a 7-ft, 6-in. tunnel through the clay, disposing of dug earth in the river for later removal by dredging. The tunnel was lined with steel plates, bolted together, and finished off with concrete 9 in. thick.



The flow diagram shows three bleed points in use, although the turbine actually has four. Each of the three supplies a closed heater; steam for the deaerating heater comes from boiler-feed-pump turbine exhausts. Makeup water from the existing mill treated-water system goes to an evaporator, supplied with steam from the first bleed point. Distilled water from the evaporator condenser, plus drips from heaters 1 and 2 and the evaporator, flows back to the deaerator.

The deaerator supplies a hot surge tank from which the feed pumps take their suction; feed-pump discharge passes through the No. 2 heater, evaporator condenser and No. 1 heater en route to the drum. The level in the hot surge tank controls makeup and drawoff of the condensate system to maintain ample feed-pump suction. Makeup is admitted to the condenser hotwell from the distilled-water tank; draw-off is taken from condensate-pump discharge to distilled-water tank.



Construction of the power house has been designed to give economy without sacrifice of durability. The steel-frame building is sheathed with an insulated-metal "sandwich" consisting of galvanized corrugated steel sheets attached to the girts, a center layer of ⅜-in. gypsum board coated with heat-reflecting aluminum foil, and a weather-resisting outer facing of asbestos-and-asphalt-protected metal. The protected metal, known as "vee beam", has extra-large corrugations, 1¾ in. deep and 5 in. wide, which give architectural character in conformity with the scale of the building. The entire construction has a heat loss no greater than that of a 12-in. brick wall.

Similar asbestos-and-asphalt-protected vee-beam, faced on the exposed underside with a factory-applied aluminum finish, forms the basis of the roof deck, being topped with a layer of fibreboard insulation carrying a built-up asphalt roofing. Parapet coping, belt courses around the building and window trim are also of asbestos-and-asphalt-protected metal. Estimates indicate a substantial saving as compared with a "minimum" brick building.

Principal New Power Equipment—No. 3 Power House

Carnegie Illinois Steel Corp, Rankin, Pa.
Stone & Webster Engineering Corp, Engineers and Constructors

Steam-Generating Equipment:

Boiler, water walls, superheater, setting.....Riley Stoker Corp
One 4-drum unit, 32,500 sq ft heating surface; 7,860 sq ft superheater, 12,780 sq ft water-cooled furnace; continuous rating 450,000 lb per hr at 585 lb per sq in. drum pressure, 750 F at superheater outlet; guaranteed full load efficiency with blast-furnace-gas fuel 80.3%, with coal 85.8%; heat release in furnace with gas 22,300 Btu per cu ft, with coal 21,000 Btu per cu ft. Furnace volume 28,000 cu ft
Economizer, 9150 sq ft.....Riley Stoker Corp
Air heater, 38,500 sq ft.....Riley Stoker Corp
Soot blowers.....Diamond Power Specialty Corp
Soot blower water pump.....Wilson-Snyder Mfg Corp
Boiler heat insulation.....Eagle-Picher Sales Co
Power control and safety valves; Consolidated Ashcroft Hancock Div
Non-return valves.....The Edward Valve & Mfg Co
Feedwater regulators, 2-element.....Northern Equipment Co
Coal burners, four No. 5 Riley.....Riley Stoker Corp
Coal pulverizers, two duplex.....Riley Stoker Corp
Blast furnace gas burners, 4.....Freyn Engineering Co
Ignition oil burners, 8.....The Engineer Co
Ignition oil pumps.....Quimby Pump Co
Ignition oil heaters.....Whitlock Manufacturing Co
Ignition oil unloading pump.....Geo D Roper Corp
Combustion control.....Hagan Corp

Draft Equipment:

Forced-draft fans, two.....B F Sturtevant Co
325,000 lb per hr, 80 F air at 10.5 in. static pressure each, with inlet vane control and outlet dampers
Motors, two, 200 hp at 725 rpm, each.....Elliott Co
Induced-draft fans, two.....B F Sturtevant Co
600,000 lb per hr, 550 F flue gas at 10 in. static pressure each with inlet vane control, inlet and outlet dampers
Motors, two, 600 hp at 725 rpm each.....Elliott Co
Steel platework.....Youngstown Steel Tank Co
Stack, 15 ft dia x 60 ft high, Cor-ten steel Gunite lined
American Bridge Co

Feedwater System:

Boiler-feed pumps.....Wilson-Snyder Mfg Co
Three 600,000 lb per hr, 3600 rpm, T D H 2010 ft.
Feed-pump turbines.....Murray Iron Works Co
Three, 822 hp, 3600 rpm, 550 lb, 750 throttle and 11 lb gage exhaust
Automatic feed-pump control.....Hagan Corp
Closed heaters, evaporator and evap condenser.....Alco Products, Inc
Evaporator preheater.....Elliott Co
Contact type cast iron shell and trays with 13 sq ft vent condenser
Deaerator and hot surge tank.....Cochrane Corp
Tray-type contact deaerator with 500 sq ft vent condenser and 13,500-gal hot surge tank. Discharge capacity 442,830 lb per hr of condensate at 334 F, 10,300 lb steam per hr at 1248 Btu enthalpy.
Evaporator preheater feed pumps.....Wilson-Snyder Mfg Co
Two, motor driven, 25 gpm, 35 ft T D H.
Evaporator feed pumps.....Wilson-Snyder Mfg Co
Two, motor driven, 30 gpm, 270 ft T D H.
Distilled water pump.....Wilson-Snyder Mfg Co
One, motor driven, 300 gpm, 125 ft T D H.
Heater and surge-tank level controls.....The Swartwout Co

Power-Generating Equipment:

Turbine-generator.....Allis-Chalmers Mfg Co
One 32,000 kw, combined extraction condensing 1500-rpm turbine. Throttle 550 lb, 750 F. Extraction at 180 lb, 91 lb, and 8.7 lb abs. Exhaust 1.5 in. Hg abs. One 3-phase, 25-cycle, 13,800-volt, 0.80-pf, 40,000 kva generator with direct-connected main and pilot exciters.
Generator air coolers, 4, 4640 sq ft.....Schutte & Koerting Co
Lubricating-oil coolers, two.....Griscom-Russell Co
Condenser.....Allis-Chalmers Mfg Co
One, 35,000 sq ft, 2-pass, 1-in. Admiralty tubes.
Circulating-water pumps.....Allis-Chalmers Mfg Co
Two 20,500 gpm, 42 ft T D H; 300-hp, 365-rpm motors.
Air-removal equipment.....Allis-Chalmers Mfg Co
Two twin steam-jet pumps and one hogging ejector.
Condensate pumps.....Allis-Chalmers Mfg Co
One motor- and one turbine-driven, for 850 gpm at 210 ft T D H.
Atmospheric relief valve.....The Edward Valve & Mfg Co

Auxiliary Equipment:

Turbine-room crane, 100 ton.....Morgan Engineering Co
Automatic coal scales.....Richardson Scale Co
Coal-handling equipment.....Link-Belt Co
Ash- and fly-handling equipment.....United Conveyor Corp
Blast-furnace-gas goggle valves.....William M Bailey Co
Blast-furnace-gas butterfly valves.....Freyn Engineering Co
Phosphate feed pump.....Worthington Pump & Mach Corp
Sulphite feed pumps.....Hills-McCanna Co
Lubricating-oil filter and pumps.....S F Bowser & Co, Inc
Lubricating-oil centrifuge.....De Laval Separator Co
Fire pump.....Wilson-Snyder Mfg Co
Fire-pump turbine.....Terry Steam Turbine Co
Sump pumps.....Yeoman's Brothers Co
Pump house drainage pump.....Wilson-Snyder Mfg Co

Meters and Instruments:

Recording thermom, pH and conduct recorders—Leeds & Northrup Co
CO_2 recorder.....Leeds & Northrup Co
Air-flow steam-flow meter, dual fuel, compensated....Bailey Meter Co
Fluid-flow meters.....Republic Flow Meters Co
Multiple-point draft gages.....Ellison Draft Gage Co
Indicating pressure gages.....Star Brass Mfg Co
Dial thermometers and temp controllers.....C J Tagliabue Mfg Co
Water-level and vacuum recorders.....Bailey Meter Co
Indicating thermom, vacuum gages and barometer....Taylor Inst Cos

Piping and Valves:

Motor-operated circulating water valve.. The Kennedy Valve Mfg Co
Valves: The Chapman Valve Mfg Co; Reading, Pratt & Cady Co; The William Powell Co; The Edward Valve & Mfg Co; Crane Co
Pipe and fittings: Underground Steam Const Co; Crane Co; Power-Piping Div, Blaw-Knox Co
Expansion joints.....E B Badger & Sons Co
Pipe and equipment insulation.....Johns-Manville Corp

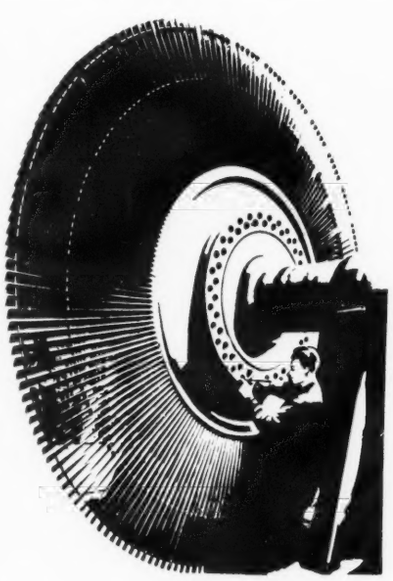
DEFENSE DIGEST

Trends, troubles, achievements, shortcomings, gossip and sidelights of the National Defense Program, with particular reference to industry's job of production, in which the power engineer is a key man

Bootlegging of strategic materials is due for heavy penalties under an aggressive policing policy now taking shape in OPM. Speculators are reported to be hoarding every kind of material for which priorities have created a seller's market. OPM intends to break up this illicit business.

An example of this nefarious activity is the case we heard of recently where a manufacturer was approached by a friend of a friend who had several hundred tons of aluminum cached in an outlying warehouse. To his horror, the manufacturer learned that the bootlegger wanted to enlist his aid in peddling the aluminum to his customers at fancy prices. Needless to say, our manufacturer put as much daylight as possible between himself and the ghoulish peddler. POWER readers who hear of such bootlegging activities are asked to write the editor or advise the OPM; there is no excuse for such predatory tactics at any time, least of all in time of emergency.

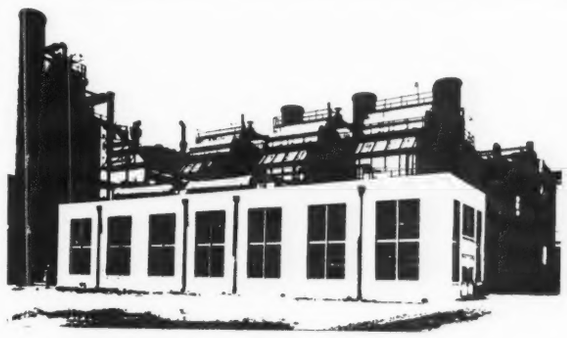
The way to get more power quickly is to use present idle capacity, not to start damming a river. Engineers have heartily endorsed diversion of another 8000 sec-ft at Niagara Falls to make about 50,000 kw in the U. S. available for strategic chlorine production. The additional water now flows through old but still efficient "umbrellas" in the Adams No. 2 plant. Even with the added diversion there is still some capacity at the Falls idle because authority is lacking to use water that now contributes only to scenic effect.



The thesis that aluminum must be made by "cheap" hydro power is responsible for the excited agitation to appropriate money for the St Lawrence waterway project costing 238 million dollars and requiring at least four years to construct. While the arguments are long and involved, we would like to point out that 238 million would build a lot of steam plants much more quickly, and leave enough spare dollars to keep several coal miners busy for the duration of even a long war.

Utility sales to wholesale customers are running 30% above corresponding months last year. This, the best index we have of actual production, means that our entire industrial machine is geared about a third faster than last year. However, it is important to note that this increase in industrial loads is accompanied by only about 18% increase in total kwhr generated by public utilities. Also, peak loads are not going up as fast as kwhr sales, being only about 13% above last year's corresponding month.

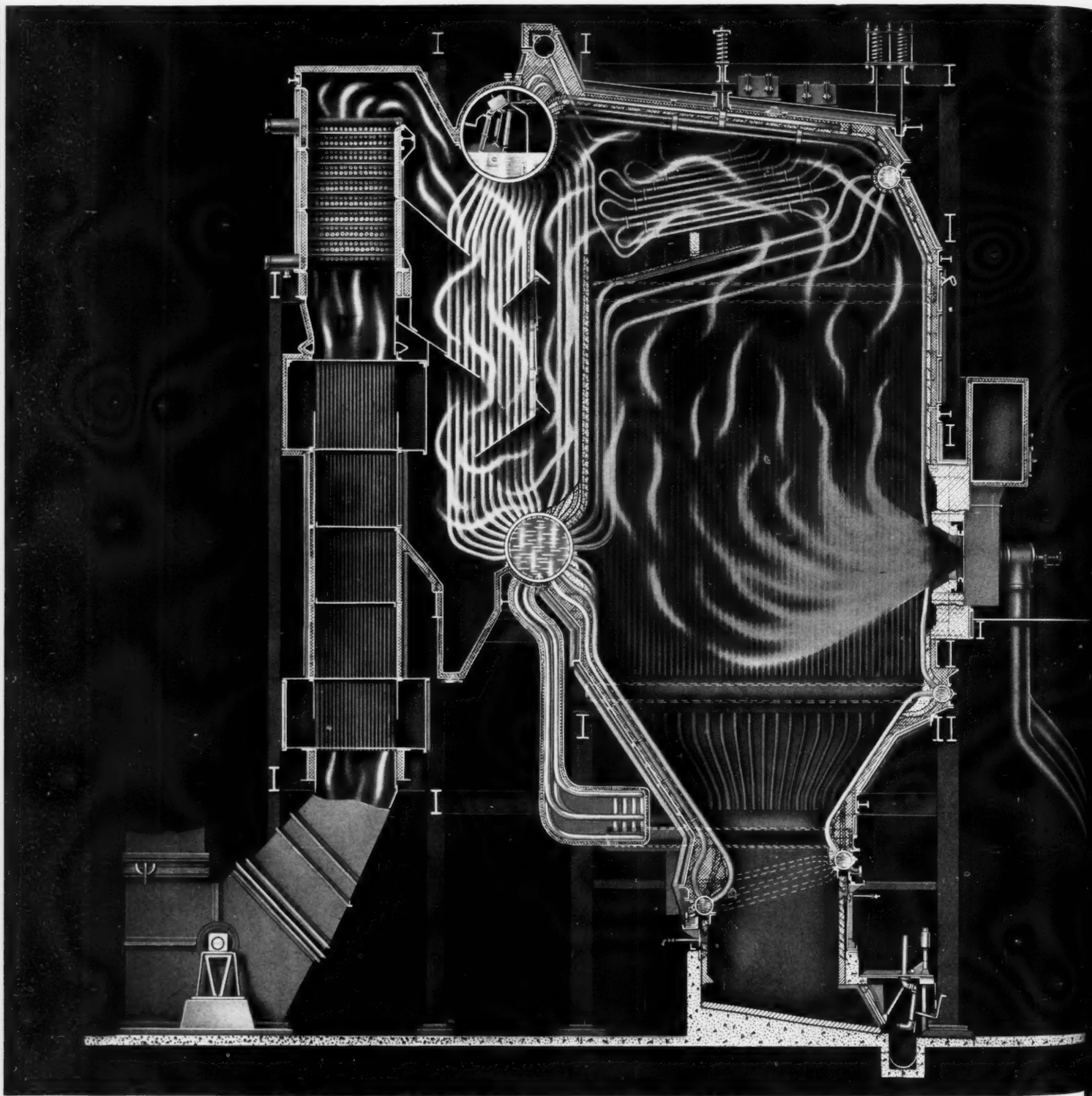
The "power pool" in the Southeast, announced with fanfare by the FPC last month, is not exactly new. Many of the utility companies had been interchanging power with TVA and the Aluminum Co for a long time back. However, extension of the area contributing to the aluminum supply as far north as Cincinnati, west to Texas and south to Florida will be of considerable help in relieving a situation that cannot help but become more serious before heavy rains bring relief.



Buy coal now! Power-plant operators can serve their own ends and aid the defense program by stocking fall and winter coal requirements this month. Forehanded retail coal dealers are conducting a vigorous campaign to induce domestic users to stock the winter's supply now. Likewise, it is sound practice for steam-coal users to store up this month when railroad loadings are still relatively light, thus relieving congestion in September and October when heavy shipments of coal and other bulk materials will undoubtedly give the railroads all they can handle.

Another factor to consider is that the government is advocating conversion from oil to coal as industrial fuel in the East to relieve tanker shortage. Industrial fuel oil runs about 25% of the volume of shipments by tanker to the East coast and reduction in this line would make that much more capacity available to bring crude and gasoline from Gulf ports. This policy, however, puts an added strain on coal transportation facilities. POWER can give its readers no sounder advice—STOCK UP NOW!

Riley Promised these Users Unusual Results



TYPICAL RILEY PULVERIZED COAL FIRED BOILER UNIT

TRADE MARK Rx REGISTERED

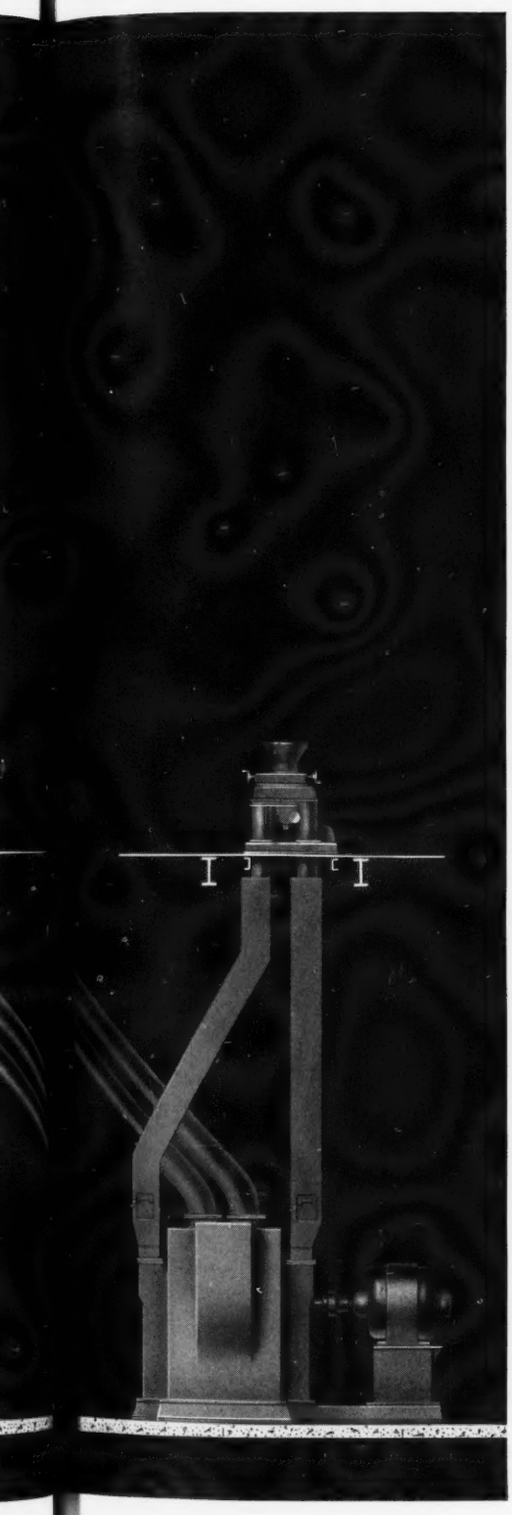
RILEY

STOKER CORPORATION, WORCESTER, MASS.

Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Seattle Baltimore Richmond Denver
St. Louis Cincinnati Houston Chicago St. Paul Kansas City Los Angeles Atlanta Memphis New Orleans

It will pay you to visit modern Riley Installations

...Here is how the promises were fulfilled



Riley's promise of unusual results is entirely justified by actual performance of existing installations. Installation after installation is operating at higher efficiencies and greater steam capacities than guarantees and with complete reliability and a minimum of maintenance. Riley's rapid progress in the boiler industry can be attributed to the fact that users have found that Riley claims and guarantees are invariably exceeded in actual operation. That is why we say you owe it to yourself and your company to investigate Riley equipment.

Higher Actual Efficiencies than Guarantees

Winchester Repeating Arms Co.	Actual	87.4%	Guarantee	86.5%
Ohio Salt Company	"	85.3%	"	83.8%
Shell Oil Company	"	85.5%	"	84.8%
Lynn Gas & Electric Co.	"	87.7%	"	86.1%
General Aniline Co.	"	88.7%	"	86.5%
Union Public Service Co.	"	87.3%	"	85.7%
Large Eastern Refinery	"	86.7%	"	83.3%
Container Corp.	"	79.55%	"	77.6%
Upper Mich. Power & Light Co.	"	86.3%	"	85%
Godchaux Sugars, Inc.	"	85.7%	"	82%
Savannah Sugar Co.	"	86.2%	"	85.6%

Greater Steaming Capacity than Guarantees

Masonite Corp.	Actual	70,000	Guarantee	50,000
Allis Chalmers Mfg. Co.	"	180,000	"	150,000
Standard Oil Co. of Calif.	"	146,000	"	125,000
Lynn Gas & Electric Co.	"	260,000	"	205,000
Pennsylvania Sugar Co.	"	320,000	"	250,000
Celanese Corp. of Amer.	"	175,000	"	150,000
Winchester Repeating Arms Co.	"	90,000	"	75,000
Wheeling Steel Corp.	"	120,000	"	100,000
Univ. of Minnesota	"	125,000	"	100,000
Ames Worsted Co.	"	85,000	"	70,000
Nevada Consolidated Copper Co.	"	135,000	"	100,000

Recent Repeat Orders from These Companies Further Indicate the Unusual Results Being Obtained from Riley Units

Central Ill. Light Co.	Carbide & Carbon Chem. Corp.
Allis Chalmers Mfg. Co.	Norton Company
Houston Lighting & Power Co.	Curtiss-Wright Corp.
Dow Chemical Company	American Brass Co.
Northwestern Public Service Co.	Western Cartridge Co.
Standard Oil Co. of Calif.	Bullard Company
Celanese Corp. of Amer.	General Motors Corp.
Winchester Repeating Arms Co.	Scovill Mfg. Co.
Union Electric Company	Carnegie-Ill. Steel Corp.
Masonite Corp.	Crown Cork & Seal Co.
Standard Oil Co. of N. J.	Republic Creosoting Co.
Humble Oil & Refining Co.	Shell Oil Co.

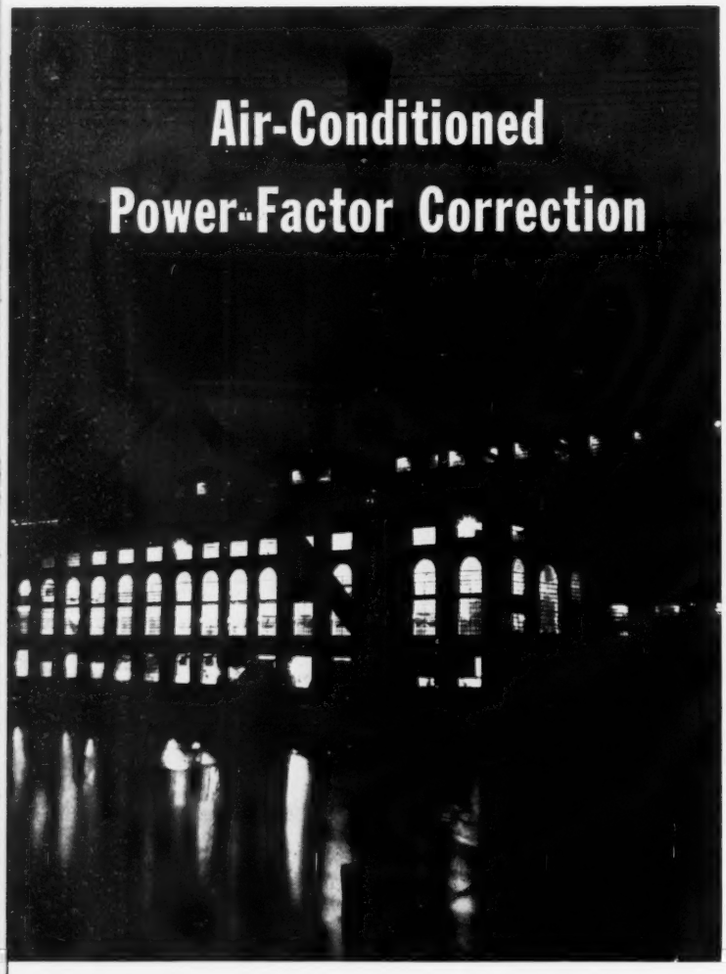
A survey of your power plant by a consulting engineer will possibly show ways of making surprisingly large savings in power costs

COMPLETE STEAM GENERATING UNITS

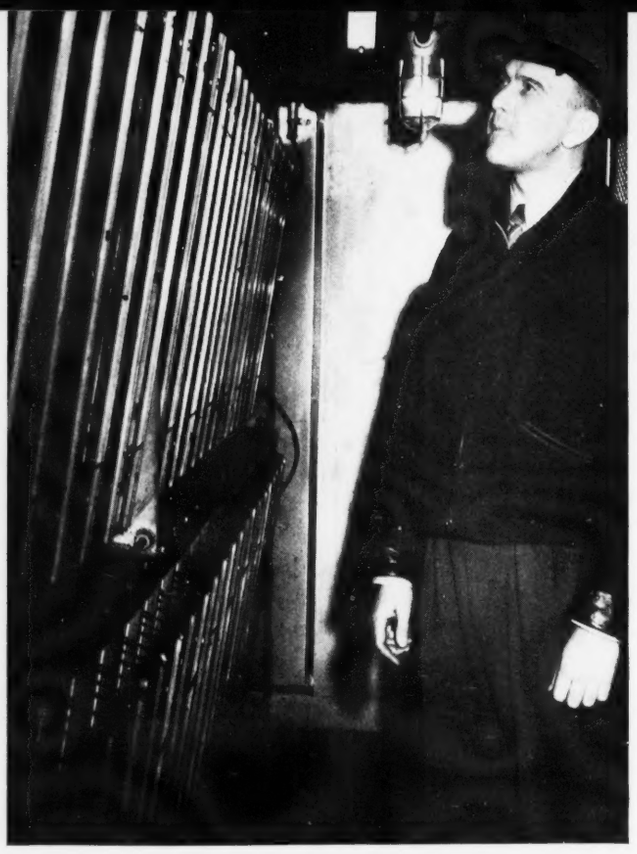
BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • AIR-HEATERS
ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • FLUE GAS SCRUBBERS

before purchasing Boiler or Fuel Burning Equipment

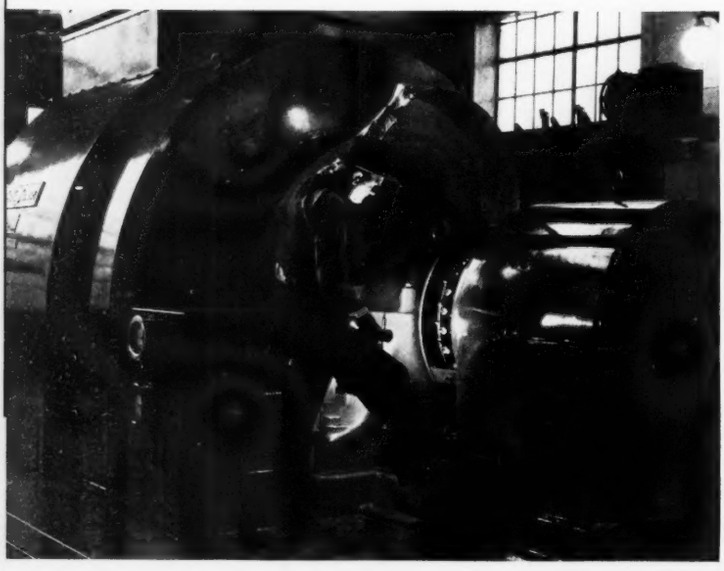
Air-Conditioned Power-Factor Correction



When power factor is low, capacity of generating units can be increased by installing a synchronous condenser, as was done at the 67,000-kw Gorge Steam Plant of Ohio Edison Co, Akron

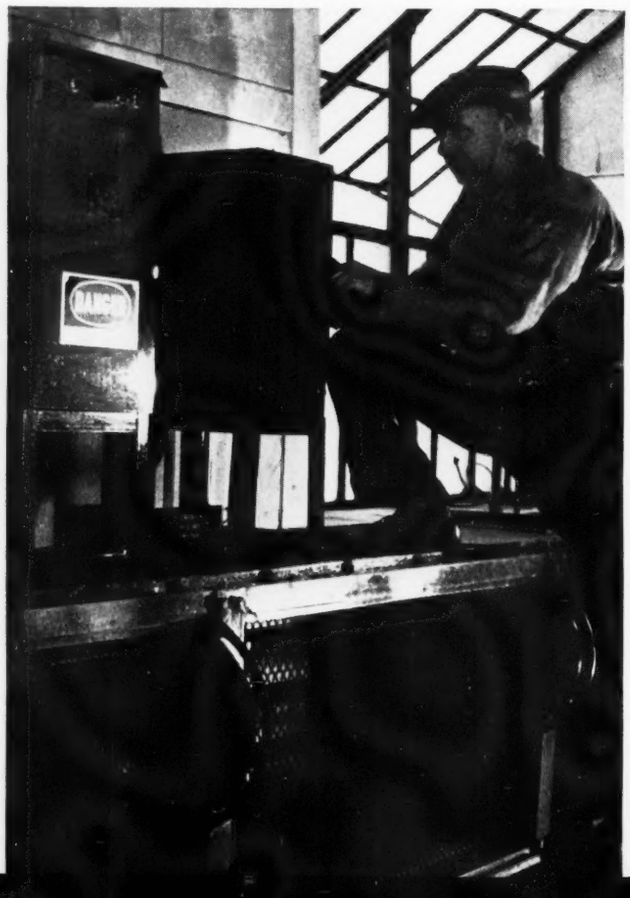


Entry side of bank of 56 Westinghouse Precipitron cells that electrostatically clean ventilating air for the synchronous condenser. Cleaning capacity of the bank is 41,000 cfm; cleaning efficiency is 85% by National Bureau of Standards blackness test



This 20,000-kva, automatically controlled synchronous condenser not only corrects power factor and increases useful output of the plant, but it also improves voltage regulation and quality of service from the system. About 40,000 cu ft of air per min, blown through the machine to keep it cool, are cleaned by an electrostatic unit, called a Precipitron

The intake for drawing recirculated air into the ventilating system of the condenser. At right an operator is opening one of the two power packs supplying high-voltage direct current to the Westinghouse Precipitrons. Engineers estimate that this cleaning installation will collect between 50 and 75 bushels of air-borne dirt per year; if this were blown into the windings, it would be necessary to dismantle the machine periodically for cleaning by hand



What CO_2 is Best?

In brief, this is how you find out: (1) operate boiler at various air-fuel ratios, but at constant output, (2) for each air-fuel ratio determine CO_2, O_2 and ½ CO, (3) plot curve of proportions of these constituents on triangular coordinates, (4) from this plot curve of heat loss for various percentages of CO_2 and (5) from heat-loss curve select optimum CO_2

By R E SUMMERS
Associate Professor, Mechanical Engineering, University of Minnesota

▶ SELECTION of the best practicable air-fuel ratio for a boiler furnace is a problem that always involves many variables. Carbon dioxide concentration in the flue gas is, of course, often controlled as a means of regulating the efficiency of fuel utilization. While CO_2 does serve as a rough index to combustion conditions its volumetric percentage in combustion products is in neither fixed nor direct relationship to combustion efficiency. Moreover, every different fuel burning installation has its peculiar behavior as does every different fuel.

Application of control principles is herein made to a wood-burning furnace, partly because wood affords such a wide possible range of CO_2 in its products of combustion and partly because best efficiency is seldom attained in the use of wood. With wood waste (See Problem 1, page 93) serving as an important industrial fuel in the Pacific Northwest and elsewhere, and with wood fuel common to a large number of small plants in all places, particularly those plants without thorough-going technical supervision, this application appears significant. Methods illustrated apply to any plant using any fuel.

Obtaining the Data

With no apparatus other than that required for routine control, once an operating program is set up, the plant engineer can determine the characteristics of each different furnace in his charge. The curve of Fig. 1 represents the performance of one wood-burning furnace at a particular driving rate. The data were obtained by operating the furnace with different ratios of air to fuel (established by draft and damper adjustment) and analyzing the flue gas produced as the result of each setting. A conventional orsat was used.

Gas compositions were written into the frequently used equation $CO_2 + O_2 + \frac{1}{2}\,CO = \text{a constant } K$. For the case at hand an average value of 19.55 for K was determined from the gas analyses. To permit plotting the individual gas

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R E Summers, Associate Professor of Mechanical Engineering at the University of Minnesota, Minneapolis, has been digging up answers to power questions ever since his undergraduate days at Oregon State College. A list of summer work, performed during the college "off-season," fills a couple of typewritten pages, but here are some of the highlights:

Special engine test engineer for Cooper-Bessemer Corp; assistant engineer for Portland (Ore.) General Electric Co; boiler-water consultant for Willamette Lumber Co; conductor of power-plant efficiency studies for Dairy Cooperative Association, Portland, Ore.

Mr Summers served on the engineering staffs of Kansas State and Oregon State Colleges before he came to Minnesota three years ago and has directed several extensive research programs, among which is the current feedwater investigation sponsored by the National Aluminate Corp, for whom he is investigating thermal conductivities of boiler steels at high temperatures.

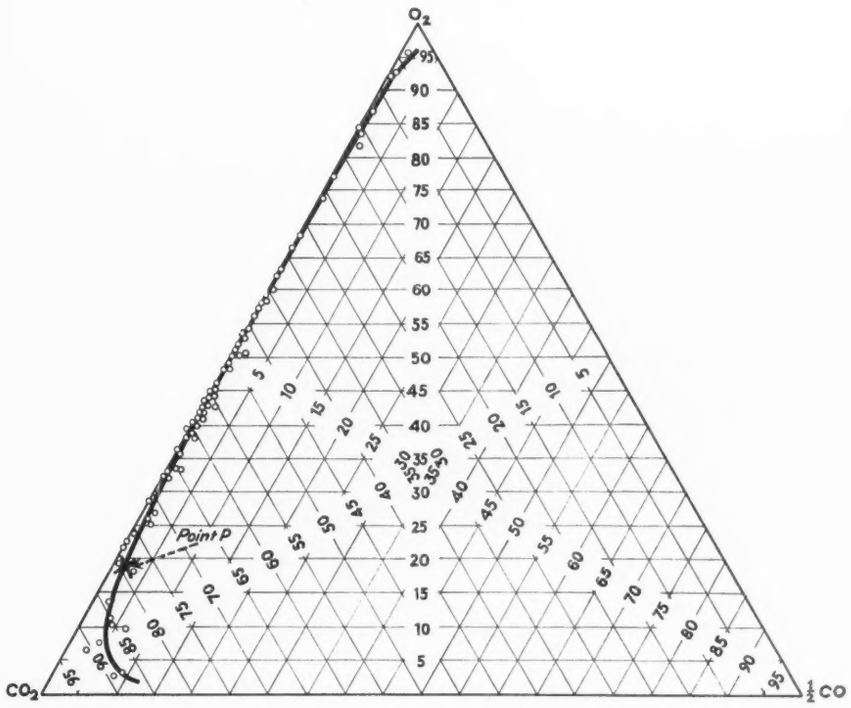


Fig. 1—Characteristic curve for wood-fired furnace at fixed output with varying CO_2

TRIANGULAR COORDINATES

THE TRIANGULAR COORDINATES used in plotting Fig. 1 will not be familiar to all readers. Since this system of plotting has important practical uses, an explanation is in order. The equilateral triangle shown in Fig. 3 is drawn with an altitude of 100 units, representing 100%. Pick any point P within the triangle and drop perpendiculars to the three sides. The lengths of the three perpendiculars will always add up to 100, regardless of the location of point P. In the case chosen the three distances are $A = 60$, $B = 15$, $C = 25$.

A diagram of this sort may be used to plot mixtures of any three constituents. (For example, various alloys of copper, zinc and lead.)

If you draw a curve within such a triangle each point on the curve represents one particular proportion of the three constituents. In Fig. 3 we say A is 60 because point P in 60% of the distance from the lower base to apex A. We say B is 15 because point P is 15% of the perpendicular distance from the left-side base to apex B. Same for C. All this becomes clearer in Fig. 4, which is ruled with three sets of lines parallel to the three sides of the triangle, so the distances may be read off directly.

In Fig. 1 Professor Summers has taken the sum of CO_2, O_2 and $\frac{1}{2}$ CO as 100% for plotting on the triangular coordinates. Thus point P in Fig. 1 represents a condition where the oxygen is 18.9% of the total of these three constituents, CO_2 is 79.5% of this total and $\frac{1}{2}$ CO is 1.6% of this total.—*Editor.*

analyses on the triangular coordinates of Fig. 1 the volumetric percentages for CO_2, O_2, and $\frac{1}{2}$ CO of any gas sample were separately multiplied by the factor $100 \div K$, using the correct value of K for the particular analysis. In this way each item in the orsat result was converted into a percentage of total of the three.

The corners of the triangular field of Fig. 1 represent gas of a single component of the three: CO_2, O_2, and CO. The base line of the chart extending between the CO_2 and $\frac{1}{2}$ CO corners represents all compositions of flue gas containing no free oxygen. The sample plotted on this line would contain nothing but carbon dioxide, carbon monoxide, nitrogen, and minor neglected constituents.

The representation of data on triangular coordinates serves to check individual gas analyses. It smooths out the experimental irregularities and affords a continuous characteristic curve of furnace operation over the whole range of air-fuel ratios, at a fixed furnace output.

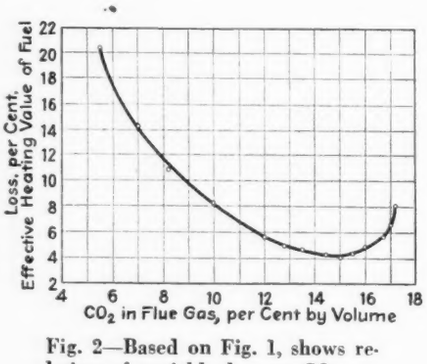


Fig. 2—Based on Fig. 1, shows relation of variable loss to CO_2

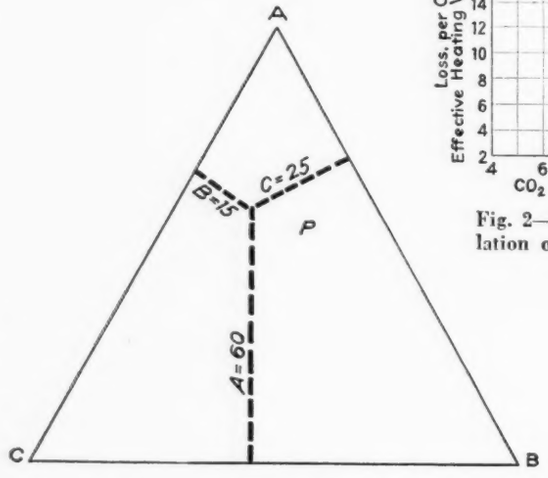


Fig. 3—Showing principle of triangular diagram. If altitude of equilateral triangle is 100, sum of three perpendiculars is always 100 regardless of position of point P within triangle. Thus point P can represent the percentages of the constituents of any 3-part mixture.

The already mentioned basic equation is essentially an oxygen balance and applies best to fuels of low free-hydrogen content. It neglects such possibly significant gas constituents as hydrogen, methane, and other unburned fuel gases. These last named furnace products should no doubt be determined more often than they now are.

The triangular diagram provides an effective means for checking sporadic orsat results. The work of Ostwald and others[1] indicates that the relation of CO_2, O_2 and CO, as combustion products of a given fuel, may not be strictly represented by a single curve. However, the influence of a specific furnace so restricts the range of values that data points depart but little from a line representing all possible conditions with one rate of fuel burning.

The furnace characteristics should be determined in this manner for the usual boiler operating rate, or for each of several common driving conditions. This done, the next step is to determine which combustion conditions give minimum total stack loss (sensible heat loss plus loss due to incomplete burning of carbon).

We shall here leave out of consideration such plant "loss" items as those due to deterioration of refractories, production of visible smoke, waste of carbon with ash, heating of air moisture, and reduction of steam superheat with reduction in the air-fuel ratio. Most often the grand total of all losses is approximately minimum when the sum of the sensible heat loss and the CO loss is a minimum. Any customary method may

(1) Gerrish, H C, and Tessmann, A M. *Relation of Hydrogen and Methane to Carbon Monoxide in Exhaust Gases from Internal-Combustion Engines.* Report No. 476 of the National Advisory Committee for Aeronautics (1933).

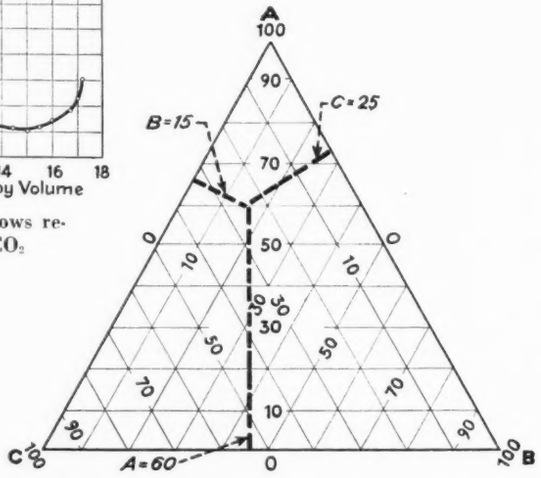


Fig. 4—Same as Fig. 3, but with parallel ruled lines added for convenient reading. Value of 15 for B means that the corresponding perpendicular runs 15% of the distance to apex B. Triangular ruled paper is obtainable from engineers' supply houses and the larger stationery stores

be used in calculating these two losses. An example of results will show the application of findings.

Select a point on the smooth curve of Fig. 1, such as that for $CO_2 = 79.5$, $O_2 = 18.9$, and $\frac{1}{2}$ CO = 1.6%. The corresponding hypothetical orsat results (obtained through multiplying each number by K, 19.55, and through multiplying $\frac{1}{2}$ CO by two to obtain the CO total) are $CO_2 = 15.54$, $O_2 = 3.70$, and CO = 0.63% by volume of total dry gas. Using the method illustrated at right, the corresponding excess air quantity is found to be 1.22 lb.

The sensible heat loss due to heating that much air an assumed 400 F degrees between supply air temperature and flue temperature is $1.22 \times 0.25 \times 400$ or 122 Btu, based on an assumed average specific heat of 0.25.

The loss in carbon monoxide is calculated as heat not obtained from the carbon, or 14,650 − 4,450 = 10,200 Btu, approximately, per pound of carbon incompletely burned. From the usual observation that carbon in CO is proportioned to total carbon in dry gas as the volume of CO is related to the total volume of $CO + CO_2$, we have

$$0.5036 \times \frac{10200 \times 0.63}{0.63 + 15.54} = 199 \text{ Btu}$$

The total loss, 122 + 199 = 321 Btu, may be expressed as a percentage of the effective heating value through dividing by 7,320, in this case, and multiplying the quotient by one hundred. This gives one point on the curve of Fig. 2.

Best Furnace Efficiency

From Fig. 2 it appears that the condition of best net furnace efficiency was attained when the carbon dioxide concentration in flue gas was about 15%. This may appear surprising since 15% is far short of the theoretical maximum of roughly 20% for the fuel burned. It is to be noted, moreover, that the theoretical CO_2 percentage is not obtained even when the air-fuel ratio is that for perfect combustion, a fact well known to power-plant efficiency men.

Application of this analysis to the individual plant at any more or less fixed operating output will disclose limiting factors, such as smoke production or high furnace maintenance cost, for which small further adjustment of schedules may be necessary. The characteristic curve of Fig. 1 clearly shows what carbon monoxide production is not the result of an unfavorable air-fuel ratio, for any given set of conditions. The curve shows also how rapidly losses increase as air supply is reduced toward the theoretical requirement; hence the importance, in the light of practical variation of air-fuel ratio, of working with CO_2 concentrations at or below the optimum.

HOW TO SOLVE PROBLEMS

1—Fuel Analysis and Air Requirement

The ultimate analysis of wood fuel dealt with in this article was considered to be as follows, in percentages by weight, dry:

Carbon, C	50.36
Hydrogen, H	5.92
Oxygen, O	43.39
Sulfur, S	0.00
Nitrogen, N	0.05
Ash	0.28

Free moisture in the "as-fired" fuel was found to be 45%, the material being in the form of sawdust and "hogged" wood stored outdoors in a rainy climate. Heating value of dry fuel was, from test, 8,960 Btu per lb.

The theoretical air requirement of a pound of dry fuel is calculated with the aid of the usual DuLong equation as

$$\text{Theo. air} = 11.6 \times 0.5036 \times 34.8 \left[0.0592 - \frac{0.4339}{8} \right] = 6.00 \text{ lb.}$$

2—Calculating Air Fuel Ratio

Any acceptable method, based on combustion gas composition, can be used in calculating the pounds of air supplied to the furnace per pound of fuel fired. The writer prefers the easily remembered methods of simple chemistry of which the following is an example. Assume CO_2 in the flue gas is 10.00% and corresponding other Orsat results from the triangular diagram, or from test, as follows. Thus, we may tabulate:

Gas Constituent	Per Cent by Vol	Mol Fraction*	Lb per Mol	Lb in That Constituent Total	C	O
CO_2	10.00	0.1000	44	4.40	1.20	3.20
O_2	9.50	0.0950	32	3.04	0.00	3.04
CO	0.12	0.0012	28	0.03	0.01	0.02
					1.21	6.26

(*) *The mol. fraction = per cent by volume ÷ 100*

Lb O_2 per lb C, in dry gas = 6.26/1.21 = 5.17

Lb O_2 in dry gas per lb dry fuel fired = 0.5036 + 5.17 = 2.60

Total O_2 from air, per lb dry fuel = O_2 for free H_2 + O_2 in dry gas

$$= 8 \left[0.0592 - \frac{0.4339}{8} \right] + 2.60 = 2.64 \text{ lb}$$

Air used per pound dry fuel fired = 2.64/0.23 = 11.48 lb

3—Effective Heating Value of Fuel as Fired

While the standard test codes do not recognize the lower or effective heating value of fuel in the rating or over-all efficiency testing of plants, the fact remains that the opportunity for improvement within any one component or factor of a machine unit is often best revealed when effective heating value enters into analyses made. A case in point is the present wherein losses chargeable to the furnace are to be isolated from all shortcomings of the plant assembly of grate or burner, furnace, and boiler. This is impressively true when fuels dealt with give rise to large percentages of moisture in combustion products, due either to much free moisture or to a high hydrogen percentage. For the wet fuel dealt with herein:

$$\text{Lb water per lb } \textit{dry wood} = \frac{1.}{0.55} \times 0.45 = 0.82 \text{ lb.}$$

Lb water from hydrogen in one lb dry wood = 9 × 0.0592 = 0.53, nearly

Total moisture from one pound of dry wood = 0.82 + 0.53 = 1.35 lb

Loss of heat due to one pound of moisture escaping the furnace uncondensed may be approximated by the empirical formula

Loss = $(1089 + 0.46\, t_e - t_f)$ Btu, wherein,

t_e = temperature of leaving moisture and gas, deg F

t_f = temperature of fuel and moisture entering furnace, deg F

0.46 = approx specific heat of steam at atmos pressure, Btu per lb, per deg F

1089 = a constant, derived from experience applied to steam tables

The heat loss due to moisture from one pound of dry wood is then, for this case

$$1.35\ (1089 + 0.46 \times 400) = 1640 \text{ Btu}$$

Effective heating value of fuel " as fired " = 8960 − 1640 = 7320 Btu per lb

For convenience in illustration it is assumed that temperature of leaving gas and moisture is constant at 500 F. Actually flue temperature will decrease as excess air is reduced, particularly at the higher outputs. It is desirable to measure actual flue temperatures corresponding to various CO_2 reductions. Results can be charted on a rough curve sheet and for any calculation of sensible heat loss there can be read off the temperature corresponding to that particular CO_2.

Adventures of an Engineer—Pioneering

With a farm mower, parts of an automobile transmission, and hand-sawed lumber from native forests, an engineering counterpart of Dr Livingstone built an overshot-waterwheel hydro plant for a friend's mission station

By W B WEST

► TWO YEARS AGO, I landed on the continent of Africa to serve as more or less a consulting engineer without pay for some Missionary groups. After a drive in an American-made automobile of almost 1000 miles through some of the most desolate areas of East Africa I arrived at the Mbereshi Mission of the London Missionary Society on Lake Meweru, near Kawambwa, Northern Rhodesia. There is one of the most unusual situations imaginable from an engineering standpoint—into a remarkably promising natural-power site has been placed a small bit of English countryside, but without any of the modern conveniences which have long been looked upon as the necessities of life.

Modern 2-story brick buildings with tile roofs and exceptionally good wood work would do credit to the campus of some great University, and, although there is an abundance of water easily available for domestic use as well as power, these and other resources have been allowed to lie fallow for many years. Still, resources at Mbereshi have not been entirely overlooked, for several years ago an ambitious effort was made to develop a part of this power. However, because of the evident lack of satisfactory technical guidance not a watt of power was ever obtained, although several hundred dollars was spent on the scheme.

Very elaborate workshops (equipped with splendid tools and materials for furniture making and general woodworking), spacious school buildings, churches, assembly halls, hospital buildings, and missionaries' houses have been erected—remarkable for even a civilized country, much less a community erected in the heart of native Africa 35 miles from a post office and 335 miles from a railroad. All the rotating machinery in the shops, such as lathes, grinding stones, emery wheels, etc, were hand-power operated. A giant wheel with cranks drove a wood lathe through a small belt.

Lack of Power Shuts Up Shop

A few years ago these shops turned out excellent furniture, but when I arrived there was little evidence of any activity. Elaborate plant and equipment stood idle while natives, with no little ability, and in many cases anxious to learn trades which could be applied in the not far distant copper mines at Ndola, idled away the hours.

It was into this ripe-for-action situation I arrived in October, 1939, with well over 500 lb of machinery with which to construct and install an overshot water-wheel and connect this to a small 220-volt generator (taken along in the automobile) to supply some 30 to 40 forty-watt lamps for a friend, the Rev Griffith Quick, principal of the Mbereshi Boys Training School. The two of us met on a ship en route from London to Lobito, Angola, during the first few weeks of the present international conflict.

Gear mechanism of the farm mower (speed ratio 28 to 1) is connected to an automobile transmission box to give a ratio between waterwheel and generator of 168 to 1

While on the ship in September, 1939, we discussed the power situation at Mbereshi. Rev Quick told me about the very unusual hydroelectric possibilities at his station, so we got in touch with some manufacturers of small hydro plants in the U.S.A. in the hope that a modern installation could be made. However, the war and its economic effects in England made this impossible. Our next thought was to improvise a small plant out of equipment obtainable in Africa, take part of this to Mbereshi, build the wheel and install the plant.

It seemed obvious, under the conditions encountered, that an overshot water-wheel would be the most suitable temporary solution to the problem. Rev Quick made an excellent survey of the station and sent this to me at Umtali, Southern Rhodesia. A maximum of about 5 cfs and a head of something between 6 and 15 ft were available within transmission distance at 220 volts from points of consumption. As a compromise size, 9 ft was selected at Umtali as the tentative diameter of the wheel and construction was started at that point, for little machinery could be obtained within several hundred miles of Mbereshi Mission.

Since the problem of speed ratio between a slow-moving overshot water-wheel and high speed of the average small electric generator was acute, I hit upon the idea of utilizing certain parts of an old discarded farm mowing machine, with these changes: Rims were removed from the two drive wheels and pipes were driven onto their spoke ends to increase the diameter of the wheel to 9 ft. The axle was

in Africa

withdrawn, after which the axle housing (mower frame) was cut at two points—immediately to the right of the gear box adjacent to the left wheel and just inside (or to the left) of the roller bearing of the right wheel. Position of the right wheel and that of the left—together with the accompanying gear box—were interchanged to throw the gear box on the outside of what has becomes the right wheel and thus make possible construction of a water-wheel between the pipe-extended spokes of the old mower.

Into Darkest Africa

The mower was obtained in Umtali and cut up there. Then the "remains" and the small electric generator were loaded into the car and taken 170 miles (over a good road) to Salisbury (modern Capital of Southern Rhodesia), where the pipes were obtained, cut and suitably shaped with flattened and drilled outer ends to receive the wooden side disks between which the water-wheel buckets were to be installed. These pipes, together with a longer one to be used as a shaft, were also loaded upon the car, and the long journey of some 830 miles to Mbereshi was begun.

At places on the route—it is over 200 miles between points where gasoline may be obtained—and throughout the entire distance less than six other motor vehicles were seen outside small communities. (Gasoline increases in cost as one leaves the coast and finally reaches the price of $1.00 a gallon at Kawambwa).

Building the Waterwheel

At Mbereshi, the machinery was unloaded from the car, a pit was dug near one of the carpentry shops, and supports were erected on each side of this upon which the water-wheel was constructed out of native lumber sawn by hand. Every effort was made to balance the wheel, yet a counterweight of about 20 lb had to be installed inside the buckets on one side. Thereafter it moved so easily that a child could turn the 1000-lb wheel with a finger as it rested on roller bearings.

When the wheel was finished, we faced the problem of moving it to the point of installation. There was no heavy handling equipment available, not even a hoist. A number of native boys and men were pressed into service to transport and place the wheel. A highly successful installation was made without any accident.

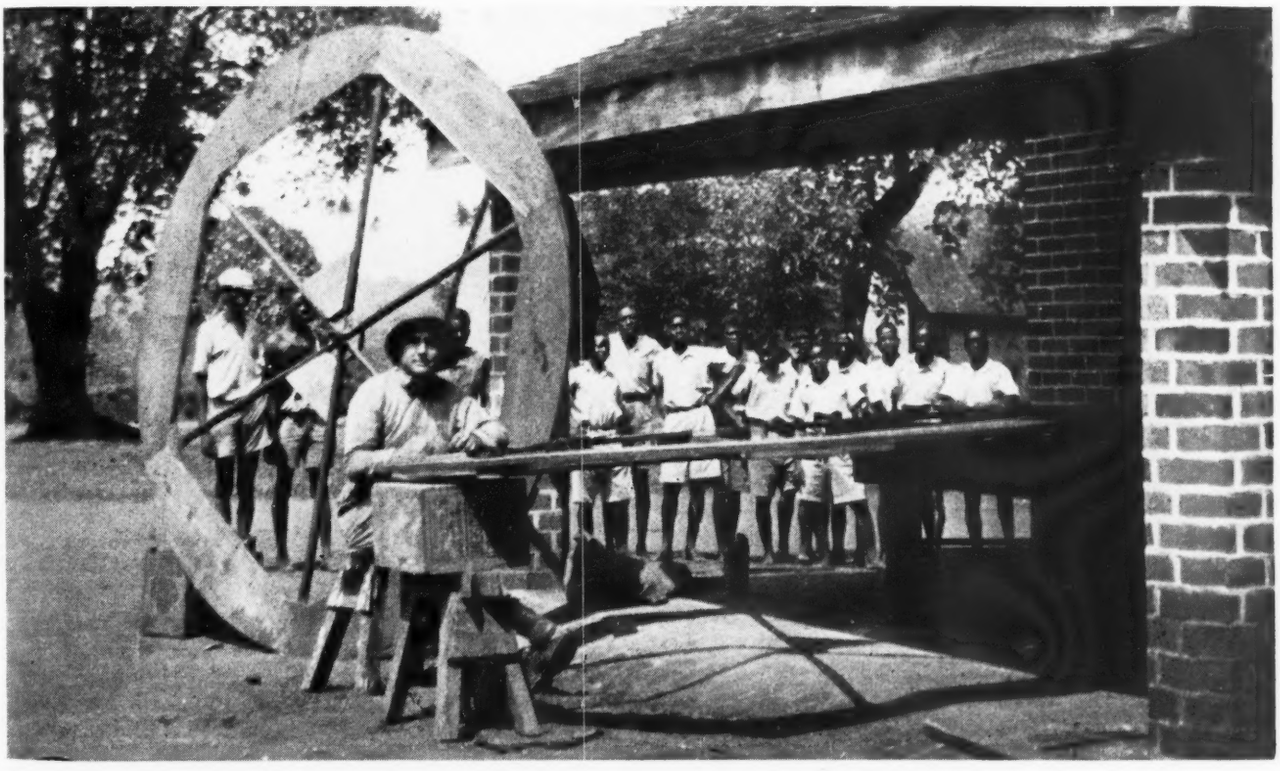
The gear mechanism of the mover has a speed ratio of 20-to-1, and the high speed shaft of this is connected to the back end of an automobile transmission box. Combined speed ratio between the wheel and the generator is thus 168-to-1. With the wheel turning at about 9 rpm the generator is driven at the necessary speed of 1500 rpm. Power is transmitted over a solid bare copper wire some 900 feet to a missionary's home, a school assembly hall and (to be connected later) a workshop where it is anticipated that an electric motor may be utilized to drive a lathe and other rotating woodworking machinery.

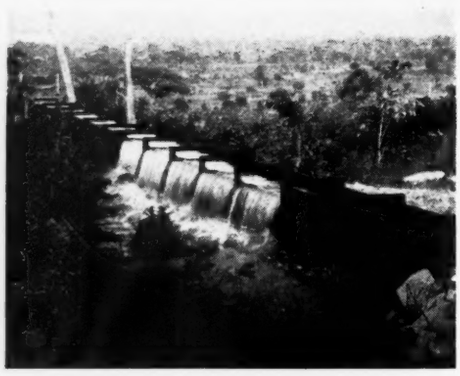
Although some of the largest copper mines in the world are within a few hundred miles of Mbereshi, there are no wire-manufacturing facilities in the vicinity and copper wire is exceedingly costly. To reduce cost of the plant as much as possible, some No. 18 copper wire formerly used for telephone purposes was adapted to power needs by stranding several wires together to form the size required.

Telephone-Wire Transmission

In this operation, one native would wind and twist the two or three wires onto a stick, two or three others would keep the individual wires straight, and another adjust them just in front of the winder twister. In this way, and by keeping almost constant supervision over the natives to make sure the wires were twisted about the same all along

The author at work with native boys laying out the overshot waterwheel





Flume carries water from the canal to a box above the water wheel. Excess above power requirements is spilled away over the side of the flume

Waterwheel and electric generator ready for operation. The flume in the background terminates in a box over the wheel. A gate, raised by a windlass and chains, releases water into the wheel via a chute. Speed of the waterwheel is controlled by manually adjusting position of the gate

their length, a relatively satisfactory cable was obtained.

Regular pin-type insulators were ordered from Southern Rhodesia and these—together with suitable cross-arms—were installed on hardwood poles. The wood is so hard (to discourage attack from white ants) that it is impossible to drive a nail into it without first drilling. At certain points it was found convenient to suspend the cable from trees by improvised "strain" insulators. At either end, the line was dead-ended through similar insulators anchored to a building or, as at the generating plant, to a securely anchored pole.

The Mbereshi River, a tributary of the mighty Congo, is mentioned by Dr David Livingstone in his "Last Journals" as having been crossed three times in the vicinity of the present Mbereshi Mission. The area is indeed one of the most beautiful in that part of Africa if one takes the time to observe and study it from many angles. The river has its origin in the woods and mountains of Northern Rhodesia, and flows through some low-lying hills as it approaches the mission that has taken its name.

A number of years ago an enterprising missionary named Bernard Turner conceived and executed the plan of tapping this stream about nine miles above the mission and bringing the water thus obtained along a contour on a slope to the mission. There the water is divided into numerous branches to serve various consumers—a hospital, swimming baths, schools, missionaries' homes, the native village adjacent to the station—and for irrigation purposes.

Site for the Wheel

The hill upon which the missionary station sits slopes off at a relatively steep grade to provide a total head of perhaps 75 or more ft in a distance of about one-quarter mile. In the opposite direction, the slope is barely enough to take drainage water in that direction. Thus, while a number of potential power sites are available on the northeast side of the mission where the slope is steep, the southwestern slope is ideal for habitation. It was upon the steep northeasterly slope that a site was selected for the first water-wheel attempt. To facilitate delivery of power to as many consumers as possible with the relatively low voltage, a site was selected as near the center of gravity of the load as natural conditions would permit.

From one of the branch canals traversing the crest of the hill along this steep hillside we cut a tap-off canal to run some 100 or more ft to a wooden flume about 60 ft long, 1.5 ft wide by 1.5 ft high. This conveys the water to a wooden box 2 ft high, 3 ft long by 2 ft wide. The box has been equipped with a suitable gate at its lower end controlled by a windlass. Water, upon leaving the box, runs along a specially constructed chute to a point about 1 in. from the tip of the water-wheel buckets. From there water is discharged about 8 in. back of the vertical centerline through the wheel so that each bucket will be approximately full when it reaches the exact vertical position; momentum of its contents is sufficient to produce a perceptible torque. Head maintained on the gate opening is about 18 in.; velocity of the impinging jet of water is just a little greater than that of the periphery of the wheel when revolving at about 10 rpm.

Natural Rpm Indicator

We did not realize at the time the wheel was being designed that the number of buckets selected (28) corresponded precisely to the speed ratio of the old mower mechanism. As one stands on the platform adjacent to the waterbox over the wheel and listens to the "tick, tick, tick" sound as each bucket passes under the end of the chute and takes water, one may also observe that as each "tick" is heard, there is a corresponding revolution of the high-speed power shaft leading from the old mower mechanism to the gear box.

To keep the flume line as low and as short as possible to save lumber, the wheel is set in a masonry and brick-lined wheel-pit so that almost half of the wheel is below the ground surface. Some second-hand arch brick was used (inverted) to form a curved surface at the back of the pit where the wheel is uniformly 6 in. from the brick as it likewise is from a line drawn vertically beneath the shaft. From that point, the pit slopes off at a grade of about 2 deg for about 10 ft, where a pool is formed in the canal by a low rock-fill dam to prevent erosion of the bottom and sidewalls.

Other Power Plants

There is a series of rapids on the Mbereshi River at a point about three miles from the Mbereshi Mission Station. Minimum flow of the river must be at least 50 cfs. It would be a great blessing to the native people as well as to the Europeans (British subjects) stationed there if a modern automatic hydroelectric plant with an alternating current generator could be installed with perhaps a 2200-volt transmission line and comparable electrical distribution system.

In this way, the hospital could be lighted and supplied with therapeutic equipment, machinery could be installed in all the shops, electric fans and lights could be made available for the missionaries' homes (as some of them have trouble enduring the tropical climate). Last but not least, the entire grounds as well as the neighboring villages could be adequately lighted to discourage lions and other wild animals.

THE OPERATING ENGINEER

George Edwards
Advisory Editor

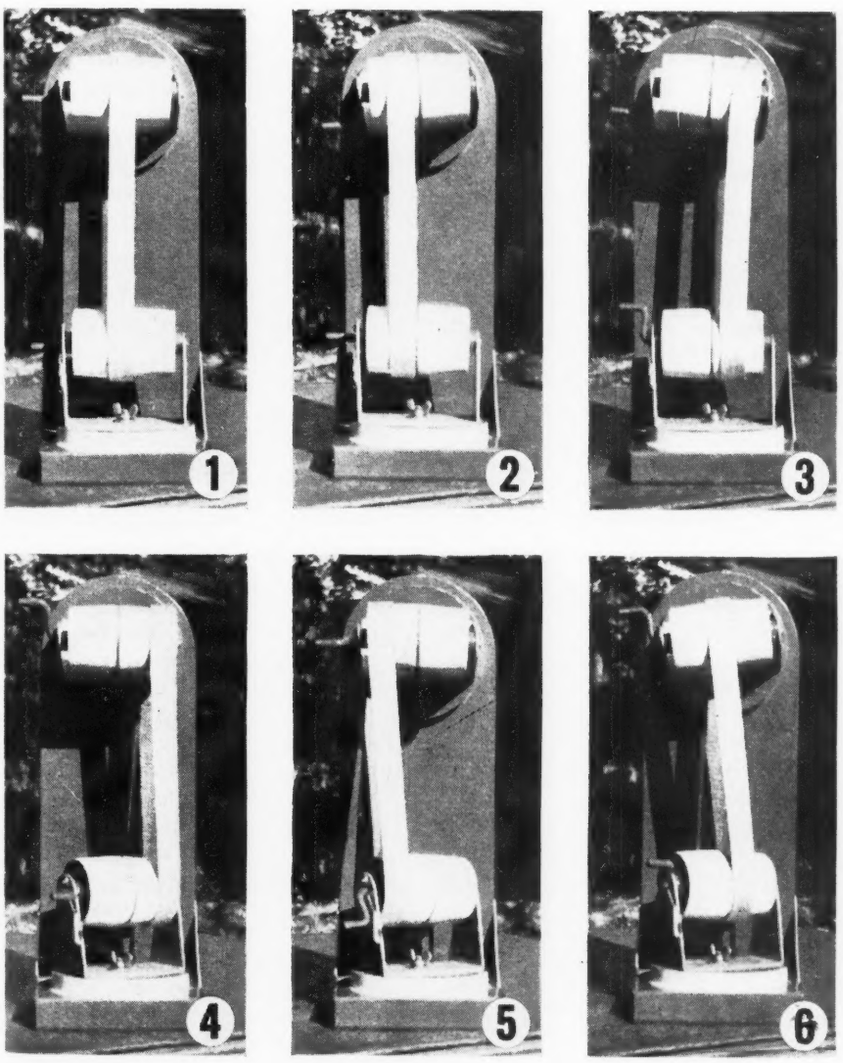
Practical Aids
Maintenance Hints
Questions — Answers

Published monthly as an integral part of POWER

Pulley Alignment Makes Flat Belts Run True

Tests show how different kinds of misalignment affect belts running on pulleys

By JAMES ADAMS, Jr
Engineer, Manhattan Rubber Mfg Div, Raybestos-Manhattan, Inc



OPERATING ENGINEERS know that a lot of belt troubles are caused by pulleys being out of alignment. Sometimes it is not easy to find out why belts do not run correctly on their pulleys, because location of the latter, their alignment and direction of rotation all influence how and where the belt will ride. We built a flat-belt-drive model to determine the effects of each kind of misalignment; the photos give the results of our tests.

Fig. 1 shows two shafts set level and parallel; the pulleys are opposite each other. This is the alignment the millwright obtains for open- or crossed-belt drives. In this case belts usually run true in their pulleys in either direction of rotation. In Fig. 2 the top pulley shaft is set out of parallel with the bottom one, which remains in the same

Fig. 1—Pulley shafts parallel to each other; belts run in center of pulleys for either direction of rotation. Figs. 2 and 3—Top shaft not level causes the belt to run over to same side of pulleys for either direction of rotation. Figs. 4 and 5—Bottom pulley set out of parallel in vertical plane causes belt to run off right side of pulleys for one direction of rotation and off the other side for reverse direction. Fig. 6—Same as Fig. 5, but top pulley is set to make belt run centrally on pulleys for counterclockwise rotation

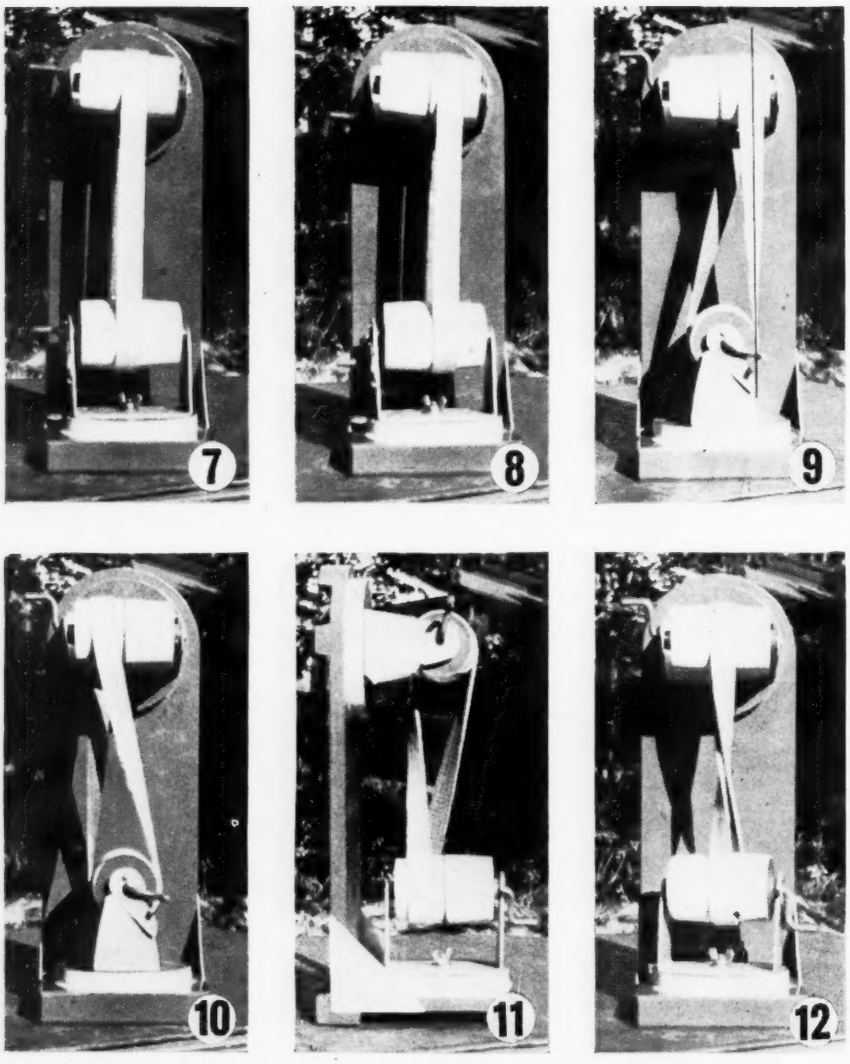


Fig. 7—Exaggerated example of alignment of the average drive, but crowns keep belt central on pulleys. Fig. 8—Pulley alignment same as in Fig. 7 but direction of rotation is reversed. Fig. 9—Quarter-turn drive, counterclockwise rotation. Fig. 10—Same as Fig. 9 with clockwise rotation. Fig. 11—Side view of the quarter-turn drive, Fig. 10. Fig. 12—Crossbelt drive with pulleys slightly out of parallel to make belt strands run clear

position shown in Fig. 1. When the pulleys are turned in either direction the belt runs to the left side of the crowns, where pulley shafts are nearest together.

The same type of misalignment is shown in Fig. 3. Here, however, the top pulley is out of alignment, causing the belt to run to the right side of the crowns where the pulley shafts are nearest together. Again, the belt runs in the same position for either direction of pulley rotation. Symptoms of the kind of misalignment, shown in Figs. 2 and 3, are that the belt rides off to one side of the crowns and keeps about the same position for either direction of pulley rotation.

In Fig. 4 the top pulley is restored to its position of Fig. 1 and the bottom pulley set out of parallel in the vertical plane with the top one, thus providing an angular drive. When the pulleys are turned in a counterclockwise direction the belt runs to the right on the pulleys. Reversing the direction of rotation causes the belt to run to the opposite side of the pulleys, Fig. 5.

This type of misalignment is recognized by the belt running toward one side of the pulleys for one direction of pulley rotation and to the other side of the pulleys for reverse direction. For extreme misalignment, as in Figs. 4 and 5, the belt will run off the pulleys entirely unless restrained. To correct this type of misalignment the shafts must be placed so that the vertical planes passing through their axes, are parallel, as in Fig. 1.

Where several machines are set out of line with a shaft, at an angle of less than 90 deg, as in some group drives, the condition shown in Figs. 4 and 5 exists between the machine drive shafts and line shafts. To make the belts run correctly on the machine and line-shaft pulleys you have to set the machines so that their drive shafts are out of parallel in the horizontal plane with the line shaft. In other words, set the machines so that their drive shaft is not level.

This condition is illustrated in Fig. 6 where the bottom pulley is set as in Figs. 4 and 5 and the top pulley is set out of level sufficiently to cause the belt to center on both pulleys. This setting of the pulleys is good for one direction of rotation only. If rotation is reversed the belt will run off the pulleys unless restrained. To operate in reverse direction it is necessary to set the top pulley out of level in the opposite position. Here again, if the drive is reversed, the belt will run off the pulleys.

In practice it is difficult to keep the shafts and pulleys in an alignment that will give perfect belt operation. Moreover, because buildings settle and because of other factors, the average shaft alignment, Fig. 7, contains some horizontal and some vertical misalignment. For one direction of rotation the pulley crowns keep the belt fairly well centered on the pulley faces and the drive is satisfactory for most practical purposes. Where rotation must be reversed, the small amount of misalignment that might go unnoticed for one direction of rotation may cause serious trouble. This is illustrated in Figs. 7 and 8. In Fig. 7, the belt centers on the pulleys for one direction of rotation; for reverse direction, Fig. 8, the belt runs over to the right of the top pulley.

Quarter-Turn Drives

A quarter-turn drive, Fig. 9, is a special case of angular misalignment where the two shafts are at right angles to each other. This drive, shown in Figs. 9 and 10, demonstrates a practical rule that must be satisfied in every well-operated flat belt drive. That is, the belt must approach the receiving pulley at right angles. Fig. 9 shows a quarter-turn drive with the pulleys turning in counterclockwise direction, which causes the front strand of the belt to go from the bottom to the top pulley.

Note that a vertical line drawn from the right-hand side of the bottom pulley passes through the center of the belt as it runs onto the top pulley. In other words, the belt is approaching the top pulley at right angles to its shaft, satisfying the rule. The rear strand does not leave the top pulley at right angles, but swings over to the left. This does not have any effect on belt operation as long as direction of motion is not reversed.

In Fig. 10 direction has been reversed

and the rear strand runs upward. This causes the belt to shift over to the left until it approaches the top pulley at right angles to the shaft, again satisfying the rule. Position of the pulleys has not been changed so that the front strand, which is now moving downward, approaches the bottom pulley at right angles to the shaft. On this model, the pulleys are wide enough to permit the belt shifting in position to satisfy the law of proper belt alignment without the belt running off the pulleys.

The cross-belt drive, Fig. 12, follows the same principles of alignment as the open-belt drive. It is, however, more responsive to corrective action of the pulley crowns because the belt easily bends laterally between the pulleys. It might appear that there is considerable chafing between the two strands of the belt where they cross. The chafing, however, is negligible on endless belts if pulleys and shafting are properly aligned so that the twist is not more than 180 deg. For more than 180 deg. the belt strands rub on each other. A twist of slightly less than 180 deg. Fig. 12, will cause the strands to clear. The pulley crowns will take care of the small amount of misalignment necessary to clear the strands.

The test of pulley and shaft alignment is a true-running belt. Since the pulleys must be set before the belt can be run, a rule is necessary for their approximate correct setting. The millwright comes close to this when he aligns the shafts and places the pulleys so that their edges are parallel to a string pulled across them.

Room for Adjustment

When pulleys are set up some room should be left for small change in position. The pulleys might be in good alignment before the belt is installed but under tension of the belt, alignment may not be as good as it was before. Amount of adjustment is indicated by the way the belt runs. If the belt favors one side of the crown in both directions of pulley rotation, misalignment is the kind shown in Figs. 2 and 3. If the belt favors one side of the crown in one direction of rotation and the other side of the crown in the reverse direction, the misalignment is that of Figs. 4 and 5.

Internal stresses in the belt determine the shape the belt will take under tension. If they are symmetrically distributed across the width of the belt, the belt will have no lateral curvature. If the stresses are unequal and one side of the belt stretches more than the other, as when it runs on the side of the pulley crown, the belt develops a lateral curvature, Fig. 13, that causes it to shift toward the top of the crown.

No two belts are exactly alike in the distribution of stresses across their width when tension is applied under the same conditions. For this reason, it occasionally happens that a new belt will not run in the same approximate position as the old belt even though pulley alignment is unchanged. Occasionally, when a belt is removed from the pulleys while repairs are being made, it is put back, turned end for end on the same pulleys. The belt may not run in the old position on the pulleys even though alignment was not disturbed. If so, the belt can be turned end for end or else pulley alignment can be altered, whichever is easier to make the belt run true.

Pulley crowns are not meant to correct poor alignment even though they help keep the belt from running off the pulleys when they are too much out of alignment. The crown should not have to do any more than prevent ever-present small deflecting forces from causing the belt to stray off the pulleys.

Excessive Crown

Insufficient crown will not produce enough curvature in the belt to keep it centered on the pulleys. Excessive crown is injurious to the belt and is a more common complaint. Belt edges should firmly contact the pulleys. If a thin knife blade can be easily inserted between the belt edge and pulley when the belt is under tension, the crown is excessive. Pulleys up to 3 in. wide generally have a radial crown of about ¼ in. per ft of pulley-face width. That is, the diameter of a 3-in. wide pulley at its crown would be ⅛ in. more than at the edge. Up to 8 in. wide, the practice is to make the crown ⅛ in. per ft of pulley face width; over 8 in. wide crown should be less.

The degree of care required in aligning pulleys depends on dimensions and elasticity of the belt. These factors determine the response which the belt makes to the corrective action of the crown. The crown is most effective when it causes in the belt a long sweeping lateral curve between the pulleys. This curve is difficult to obtain with short-wide belts, Fig. 15, and a long narrow belt, Fig. 14. A ratio of belt length to belt width of 40 to 1 is most favorable to cause the belt to center on the pulley crowns. Neither a steel nor an elastic band will respond to centering on the pulley crowns because they will not develop that long lateral curve between the pulleys, Fig. 13.

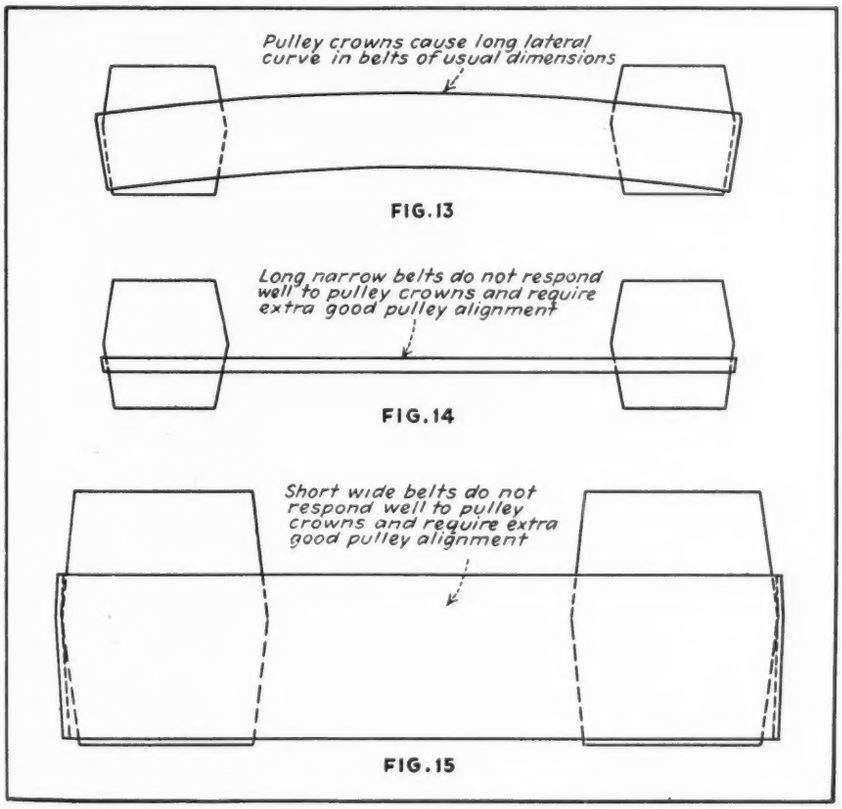

Pulley crowns cause long lateral curve in belts of usual dimensions
FIG. 13
Long narrow belts do not respond well to pulley crowns and require extra good pulley alignment
FIG. 14
Short wide belts do not respond well to pulley crowns and require extra good pulley alignment
FIG. 15

Fig. 13—Pulley crowns cause long lateral curve in belt of usual dimension to make it center on the crowns. Figs. 14 and 15—Long narrow belts and short wide ones don't respond to crowns and require extra good pulley alignment

Putting Micrometer Precision Into Machine Leveling

If you're a good machinist, you can put together this leveling device to use on any horizontal alignment job

By N L REA
Contract Service Dept, General Electric Co

BACK IN THE EARLY DAYS when a 30-kw generator was a giant and a 50-kw unit required half the factory force to load it on a car, the problem of installation was simple. A spirit level, a plumb bob and a hank of silk fish line were all the special equipment needed.

As the size of machines grew and the practice of direct-connecting them became common, the spirit level had to be supplemented by straight-edges. The span of the bases soon increased to such an extent that length of the straight-edges made cost prohibitive.

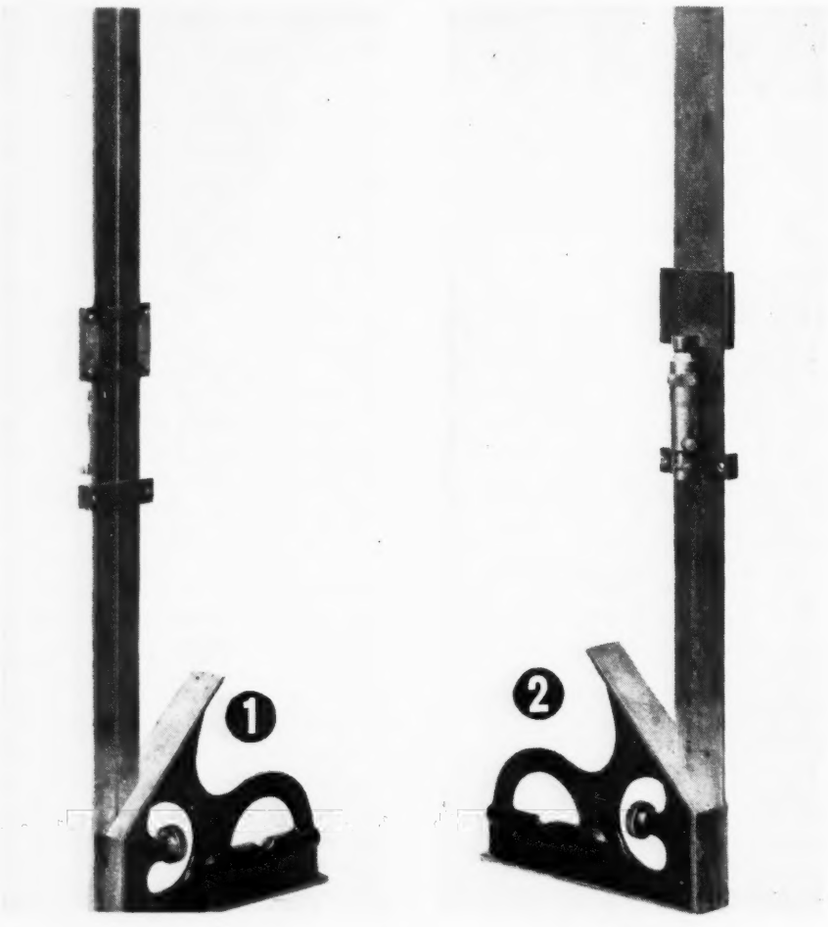
The erecting gang then turned to the surveyor's level, and for a time this served fairly well; but then we found that the average instrument man balked when we spoke in terms of sixty-fourths of an inch—and thousandths were far beyond his most excited dreams.

Increasing size and speed of equipment called for more accuracy in leveling, so we laid our problem before one of the best instrument makers. He responded with a 22-in. engineer's (or wye) level fitted with a supersensitive level vial. This solved the problem as far as the instrument was concerned, but left us with the standard target.

We soon found this was not altogether suitable, so started experimenting to find a satisfactory substitute. Several other schemes were tried, and through elimination we developed the arrangement shown in **Figs. 1 and 2.** This consists of a standard 24-in. combination square with a special target arranged to slide on the blade. The smaller bar of the target can be clamped in any position. The target proper makes a sliding fit on the blade and is pulled toward the other member by a coiled spring.

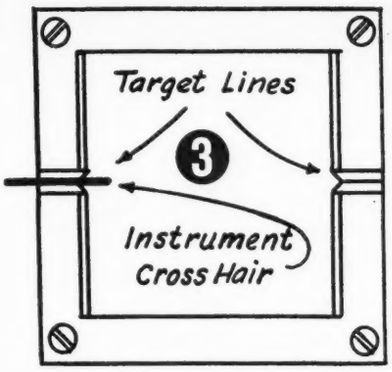
The measuring head of an inside micrometer is mounted between the two parts, and any movement of the sliding target can be read in thousandths of an inch. This type of target gives readings that can be checked within two or three thousandths, but it still has several disadvantages.

An electric hand lamp is necessary to illuminate the target. The lamp must be carefully shaded and so held that the instrument gets no direct reflected light. It must be kept in the same relative position, as change of the angle of illumination changes the apparent reading. The target and cross hairs, in use, look about like **Fig. 3.**



Lighting Difficulties Solved

Lighting difficulties caused us to continue our experiments, which ended up in the outfit shown in **Fig. 4.** This consists of a V block arranged to clamp the measuring head of an inside micrometer. The target proper is a steel ring mounted on the end of one of the micrometer measuring rods. Any length of rod can be used to suit local conditions, as we are usually interested only in the height variation from point to point, and this is read on the micrometer. The steel

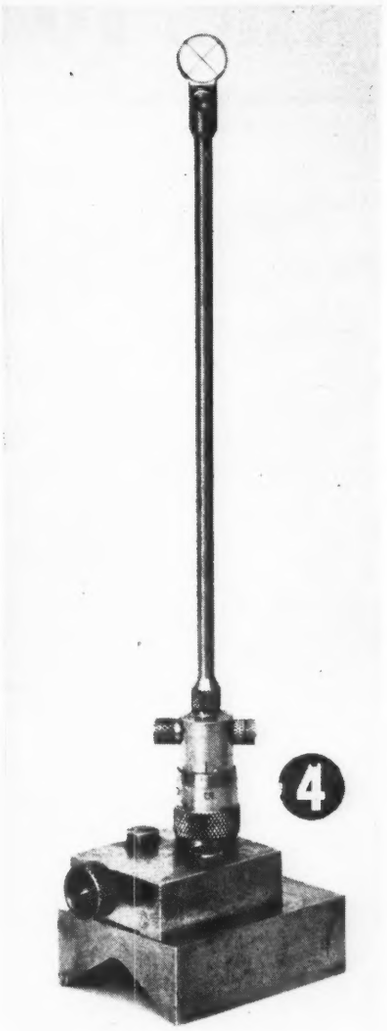


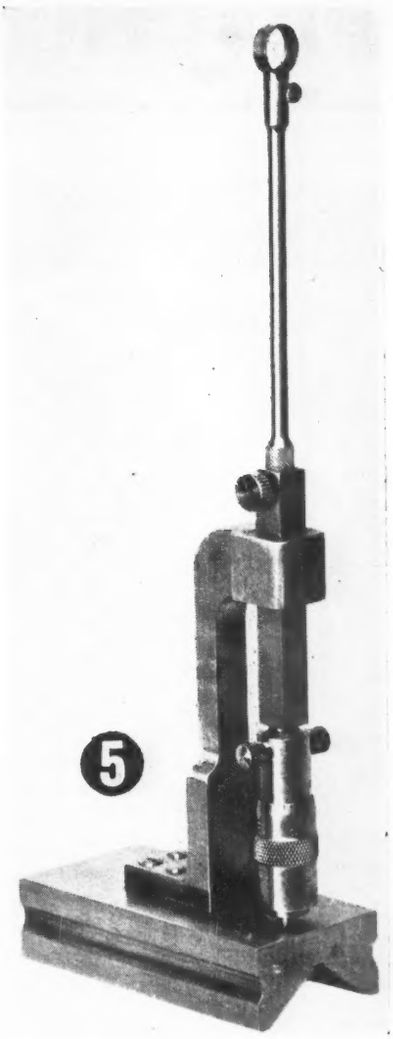
ring and the cross wires are the important elements. This form of target gives readings that check within 0.001 in., but it has one disadvantage—the target turns with the micrometer head.

To correct this trouble, we developed the outfit shown in **Fig. 5,** which has a V-base for use on a flat surface or a journal. Readings check within 0.001 in.

Now, when a large horizontal-shaft machine is assembled and operated at the factory, this "hair-splitting" device is used to level the base. The inspector makes a leveling chart showing the relative elevations of the various points on the base. A copy of this chart goes to the erector who assembles the machine in the field, and he is enabled to set and grout the base in the same position it had in the factory.

It's quite an improvement over the spirit level, plumb bob and silk fish-line equipment of the good old days!





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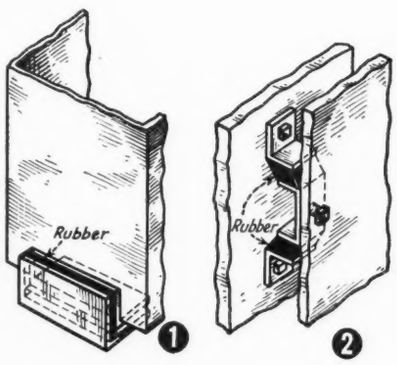
Rubber Mountings Correct Meter Readings

TEMPERATURE CONTROL based on recording-thermometer readings is an essential part of many industrial operations. Accurate notation of temperature-changes is necessary for close control. Operators in one plant were having trouble with serious distortions of temperature recordings because of instrument-panel vibrations. This difficulty was eliminated by supporting the instrument panels on rubber mountings, Fig. 2, and the cabinets in which the panels are housed on mountings as shown in Fig. 1.

Akron, Ohio R E POWERS
B F Goodrich Co



Undersize Shaft Wrecks Large Fan

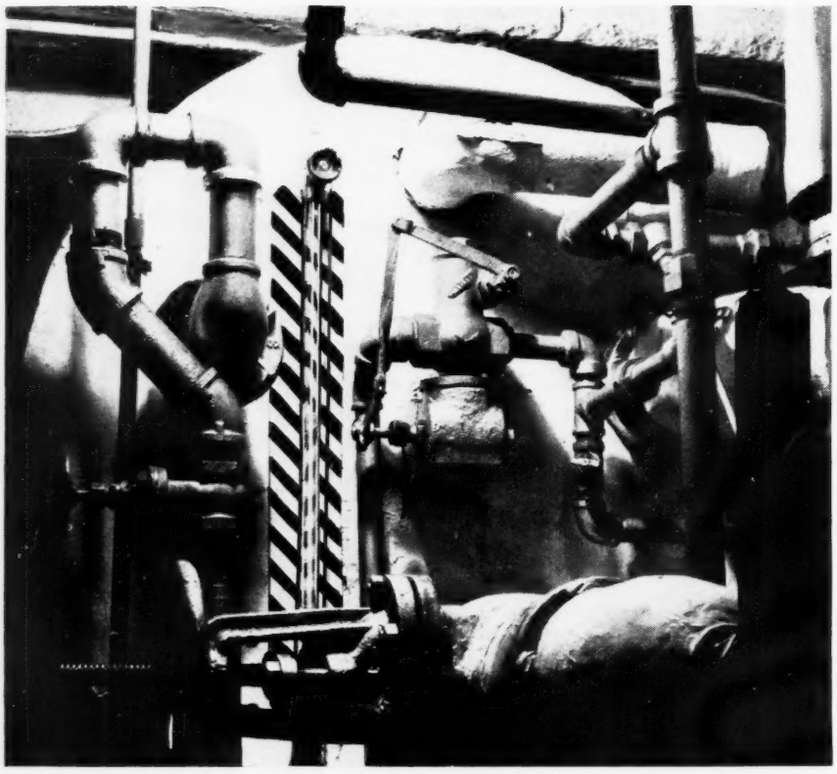
A LARGE MOTOR-DRIVEN BLOWER apparently reached a critical speed at about one-half rated speed and vibrated so badly that it seemed dangerous to go higher. The blower manufacturer's engineer claimed that the vibrations would disappear at full speed, well above critical. He also claimed that part of the vibration was due to the flexible coupling between the motor and fan. This was replaced by another design but the vibration remained.

He then admitted that the fan might be slightly out of balance, mechanically. After two or three attempts to correct this condition we brought the fan up to about 75% full speed without serious vibration, then it exploded. When a new fan was installed the rotor had a considerably larger shaft than the old one. Although it never was admitted, the fault with the original fan was mechanical unbalance; an apparently undersized shaft contributed to the damage.

Before an attempt had been made to balance the fan, it had been operated at half speed enough for the vibrations to weaken the rotor seriously. Then, after approximate balance had been attained, the rotor failed at about 75% speed. It is always dangerous to operate any machine that is seriously out of balance at *any* speed. When such conditions are found they should be corrected immediately or a costly wreck may result.

Plainfield, N. J. H W HODGSON

PRACTICAL AIDS TO OPERATION



Better Visability For Gage Glasses

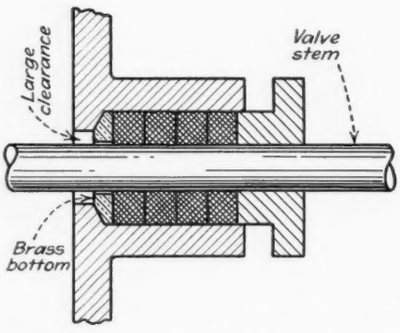
LIQUID LEVEL IN GAGE GLASSES may be difficult to read at a distance unless the liquid in the glass is magnified. The figure shows an old marine engineer's trick I have used on our feedwater-heater and other gage glasses in our power plant.

A piece of thin board painted with diagonal black and white stripes is placed back of the glass. Above the water level the stripes run in one direction only. Below the water level the stripes, as seen through the glass, run at right angles to those on the board, as in the photo. For best results the stripes should run at a 45-degree angle, be about 0.25 in. wide and placed close to the back of the gage glass.

New York, N. Y. P E MEREDITH
Chief Engineer, Eldorado Hotel

Too Much Clearance Causes Packing Trouble

WE HAD TROUBLE KEEPING THE PACKING around a valve stem from leaking. After trying several remedies to prevent steam leaking through the packing, we discovered a large clearance around the valve stem where it comes through the bottom of the stuffing box. I made a brass bottom for the stuffing box that fits around the valve stem with a close clearance, as in the figure. After putting this bottom into place and installing new packing we had no further trouble with valve-stem leaks or similar disturbances.



Riverdale, N. Y. ALEX GRAY

Worn Bearings Reduce Capacity

AN OIL COMPANY FOUND THAT ONE of its motor-driven pumps had seriously fallen off in capacity after several months operation. The manufacturer's engineer verified the loss in capacity and also found that the pump bearings were badly worn. Installing new bearings restored the pump to its original capacity.

The pump had been operated in a very dirty atmosphere and its bearings had not been properly protected. As a result, dirt and grit got into the lubricating oil and caused rapid bearing wear. This was corrected by making the bearing tight against the entrance of foreign matter.

Plainfield, N. J. H W HODGSON

Improved pH Test for Boiler Water

A SIMPLE PH INDICATOR TEST for checking boiler-water alkalinity can often give as much information to the operating engineer as a regular quantitative analysis. Such tests require no special chemical training, consume very little time and therefore encourage more frequent testing.

A few drops of the proper pH indicator added to a partly filled test tube of boiler water will immediately take on a definite color. This color is a measure of the hydrogen-ion concentration, which in turn determines the boiler-water alkalinity.

However, in my estimation, the usual pH test falls far short of giving the engineer proper alkalinity information. For example, sodium bicarbonate, sodium carbonate and sodium hydroxide are three alkaline materials commonly found in boiler waters. The pH test alone does not tell for certain which of these salts is contributing to the alkalinity of the solution. Yet the type of alkalinity present is most important.

Authorities generally agree that a small amount of hydroxide alkalinity should be established in correctly conditioned boiler water. With the aid of barium-chloride reagent, the regular pH test can be made to determine the presence of hydroxide alkalinity, thus overcoming the weakness of the test. Here's the explanation:

The alkaline salts usually found in a boiler water become insoluble in the presence of barium with the result that they lose their ionic charges and cease to affect the color and alkalinity of the solution. Barium hydroxide, on the other hand, is a soluble base, does not lose its ionic charge and will continue to register a pH value of 11.0 if present in sufficient quantity.

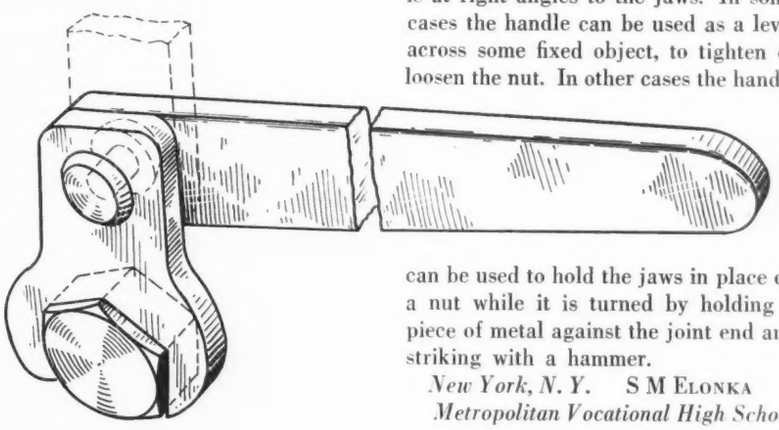
Add a few drops of pH indicator to a partially filled test tube of boiler water. Note the color change and corresponding pH value. If it is not above 11.0 there is usually an insufficient amount of alkalinity and an increase in chemical treatment is indicated. If it is above 11.0 add a few crystals of barium-chloride reagent or a small amount of a prepared solution of barium chloride to the test tube. Allow any heavy precipitate that may form in the solution to settle and again note the color. If the pH value still remains above 11.0, hydroxide alkalinity is present and boiler water is in the correct range. If the pH value falls, no hydroxide alkalinity is present and chemical dosage should be increased.

New York, N. Y. L I PINCUS
Eldorado Chemical Co

Wrench Subdues Tough Nuts

PACKING-GLAND NUTS ARE FREQUENTLY LOCATED where it is difficult to use a wrench. To lick this problem and others where nuts are hard to get at I made the joint wrench shown in the figure, made from two pieces of flat steel. One is formed for the open-end wrench to go on the nut. The handle is made up separately and connected to wrench end by a loose rivet.

Where only light tension is required on the nuts they can be turned by pulling or pushing on the handle when it is at right angles to the jaws. In some cases the handle can be used as a lever across some fixed object, to tighten or loosen the nut. In other cases the handle



can be used to hold the jaws in place on a nut while it is turned by holding a piece of metal against the joint end and striking with a hammer.

New York, N. Y. S M ELONKA
Metropolitan Vocational High School

Portable Work Bench Built By Welding

WE BUILT A PORTABLE WORK BENCH from sheet iron and angles by arc welding (see photo) that serves many purposes. The top, 24x28 in. in area, is made of 16-gage sheet iron, supported 35 in. from the floor. A base, made of 2x2.5-in. angle iron, has a 1-in. wood floor fitted into it. Four 1.5x1.5-in. angles support the top on the base and the whole structure is carried on four 5-in. rubber-tired hospital-bed casters. The casters are old ones, discarded by the local hospital but suitable for our purpose. A tool drawer in the bench, made of wood lined with 16-gage iron, slides in a 0.75-in. angle-iron guide.

Near the right-hand corner of the bench we mounted a hand grinder with an inexpensive twist-drill grinding attachment. On one side, the stone has a special surface for dressing drills. A motor driver for stones and diamond dressers is mounted back of the hand grinder when we are doing valve grinding. On the floor of the bench base we mounted a device for resurfacing and grinding diesel-engine valve seats. The photo shows a valve cage in position.

For use with the bench we also made by arc welding the 24-in.-high chair. The material consists of a 16-gage iron 12x12-in. seat, with a frame and legs made of 0.75-in. angle iron.

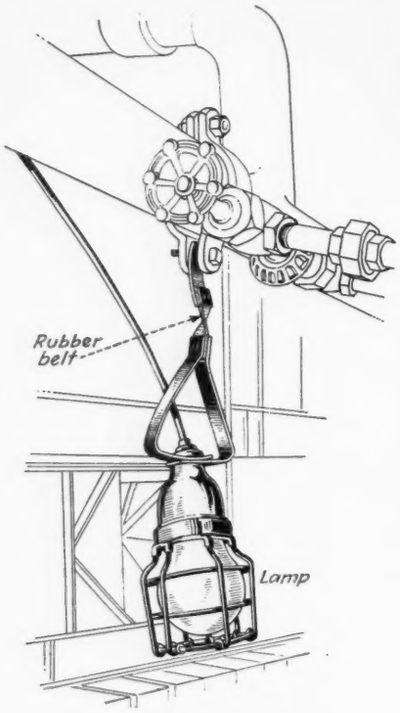
This bench has proved very handy. When work is to be done, all tools and material are loaded on it and moved to the job. Where parts are too heavy to work on at the machine, they are loaded on the bench and wheeled to

the shop, the bench being capable of carrying a load of 400 lb.

Shiprock, N. Mex. JAMES F MAHER
Assist Engr, Shiprock Power Plant

Flexible Mounting Increases Lamp Life

WE HAD THE PROBLEM of eliminating serious vibration from a lamp support and solved it by riveting a section of



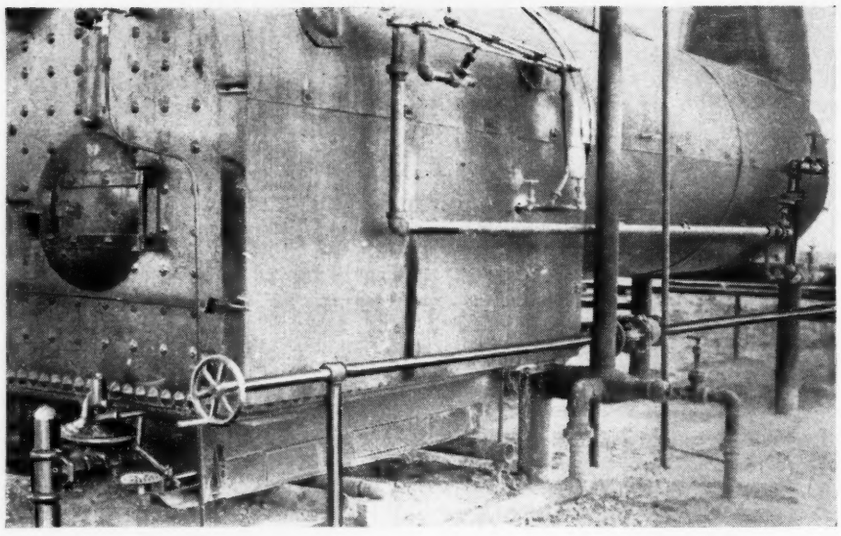
rubber belting into the supports as shown in the drawing. The flexible section absorbs vibration and even smooths out violent jerks to gentle swings. This mounting has increased lamp life.

Houston, Texas M T PATE

Pattern for Glass Disks

IF YOU ARE NOT USED TO IT you may have trouble cutting sheet glass round for the fronts of pressure and other gages. From a sheet of copper I made a round pattern of correct size to cut the glass. I hold this pattern on the glass and cut around it with a glass cutter. The outer part is easily broken off by cutting across it in several places so that it can be removed in small sections. Any rough edges on the glass circle can be removed with a carborundum stone.

Minneapolis, Minn. G K OLSEN



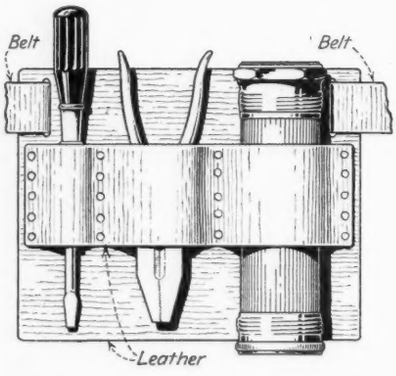
Blowdown Control At Boiler Front

WHEN ONLY ONE MAN OPERATES A BOILER and opens the blowoff valve, he must walk back to the boiler front to see how much water is going out of the gage glass. To eliminate this we extended the blowdown control to the boiler-front where the firemen can watch the gage glass and pressure gage while he opens or closes the blowoff valves.

To do this we installed a 2-in. needle valve in the blowdown line outside the blowoff valve on each boiler. The needle valve is placed so that a 1-in. pipe can be carried back to the boiler front, as in the photo. One end of the pipe connects to the valve wheel and the other to a handwheel for operating the valve. A vertical 2-ft length of 2-in. pipe and tee provide a support and guide bearing for the handwheel extension.

Now, when blowing down a boiler, the fireman first opens the regular blowoff valve. Then he goes to the boiler front and opens the needle valve, watching the gage glass. Blowdown is stopped by first closing the needle valve and then the regular blowoff valve.

Pomona, Calif. GILBERT M WILSON



Holder Keeps Tools Handy

WHEN MAKING ROUTINE ELECTRICAL INSPECTIONS I find that a screwdriver, a pair of pliers and a flashlight are the tools that I most generally require. To make sure that these will always be with me, I made a leather holder for my belt by riveting a leather strip to a piece of leather about 6 in. square, as shown. Near the top of the leather sheet two holes are cut for the belt. This carrier not only keeps the tools where they are handy, but it also prevents them from wearing out clothes, which usually happens when they are carried in pockets.

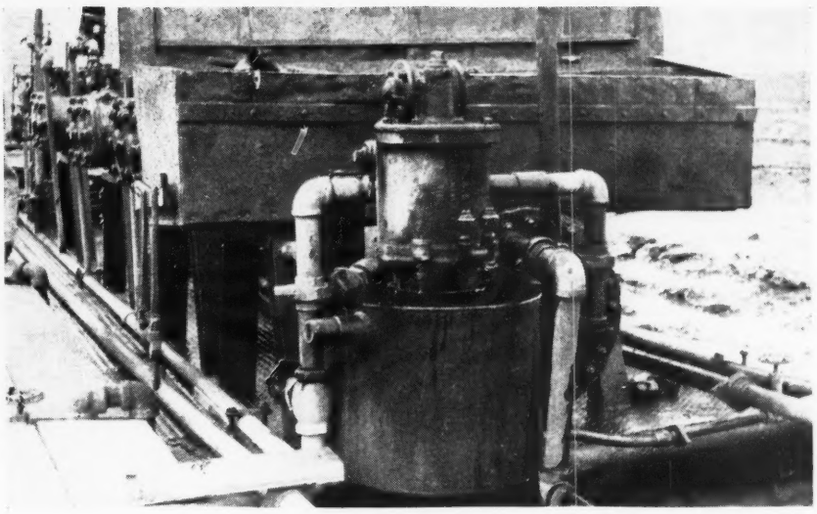
Baltimore, Md. THOMAS TRAIL

Brass Plates Identify Valves

WHEN SEVERAL VALVES are close together there is always the danger of an operator making a mistake and opening or closing the wrong one. In one plant this difficulty was solved by identifying each valve with a circular plate on the handwheels.

These plates were made of brass disks with a hole in their centers large enough for the valve stem. After stenciling the valve-designation on the disk, the nut was removed from the valve stem, the disk put in place and the nut tightened over it.

Roanoke, Va. S H COLEMAN



Water Cooling Keeps Compressor Operating

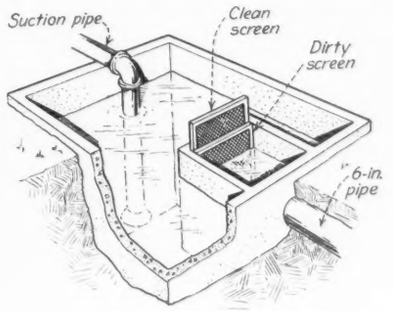
A LOCOMOTIVE-TYPE AIR COMPRESSOR USED where the surrounding air temperature was high operated at an excessive temperature that frequently caused its valves to stick. We overcame this difficulty by placing the air end of the compressor in a water tank with inlet and outlet connections as shown.

We connected this tank to the feedwater makeup line. The makeup water flowing through the tank was sufficient to keep the compressor-temperature within safe limits and permitted continuous operation no matter how high the surrounding air temperature.

Houston, Texas. CHARLES C LYNDE

Double Screen Keeps Water Clean

WATER FOR OUR PLANT COMES THROUGH a 6-in. pipe into a well, from where it is pumped when needed. Dirt and small fish were kept out of the well by a screen supported in a chamber around the end of the pipe. When the screen was taken out for

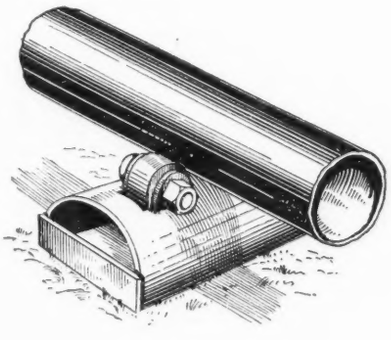


cleaning, dirt and fish sometimes got into the well. To prevent this I made a second screen. Now before we take out the dirty screen, we push it back and put the clean one in front of it, as in the figure. In this way the chamber in front of the pipe is never without a screen.

Riverdale, N. Y. ALEX GRAY

Split Pipe Sections Make Welding Dollies

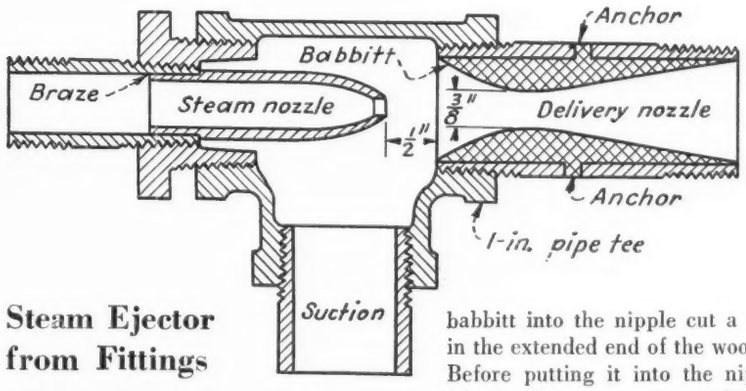
TO BUILD DOLLIES ON WHICH TO WELD PIPE we first split longitudinally a section of 6-in. pipe and then cut these sections into 18-in. lengths. We then welded short bars across each end of the sections. Pairs of lugs welded ad-



jacent to openings cut into the top curve of the pipe support bolts serving as axles for small rollers, as illustrated.

These rollers are made from short nipples of different diameter pipe nested together to form the desired diameter. The dollies are light, sturdy, inexpensive and permit one-man rotation of heavy pipe.

Houston, Texas CHARLES C LYNDE



Steam Ejector from Fittings

THE DRAWING SHOWS A CROSS SECTION of a steam ejector made from pipe fittings. I have made several of these and they work very satisfactorily on either steam or water. The delivery nozzle is made by inserting a wooden core into a 1x3-in. pipe nipple and pouring the space between the core and nipple full of babbitt. I turned the core to shape in a lathe but it can be whittled down.

Extend the wood a couple of inches beyond one end of the nipple to allow twisting the core out after pouring the babbitt. When an attempt is made to twist the core it will break at its smallest section, so that the two parts can then be easily removed.

Drill four anchor holes around the middle of the nipple and wrap some paper over them to prevent the babbitt from flowing out. To permit pouring the babbitt into the nipple cut a vee-notch in the extended end of the wooden core. Before putting it into the nipple give the wood core at coat of white lead to prevent it from smoking and causing gas bubbles in the babbitt.

I made the steam nozzle by heating and drawing down one end of a piece of $\frac{3}{8}$-in. pipe and then finished the hole with a $\frac{1}{8}$-in. drill so that it was smooth and parallel with the pipe axis. I sawed the nozzle off to proper length and brazed it into a $\frac{1}{2}$-in. nipple.

Make the length of the steam nozzle such that it will be about $\frac{1}{2}$ in. away from the delivery nozzle, when screwed in place. Make the delivery nozzle throat slightly less than $\frac{3}{8}$ in. in diameter and then scrape to $\frac{3}{8}$ in. size. In this way the throat can be made nice and smooth and if the ejector is otherwise properly made it will handle a large amount of water or steam.

Butte, Mont. C O HAGEN

READERS' PROBLEMS

Questions from Our Readers

Belt Alignment

Question 1

WE ARE HAVING TROUBLE *with the variable-speed arrangement on our twin engines. The lower cone shaft is level and parallel with the flywheel shaft; the upper cone shaft is parallel with the lower shaft and the guides are plumb, or at right angles to the cone shafts. When the belts are at the left, as shown in the sketch, and about 2½ in. from the end of the cones, the wrapping belt is ⅛ in. off the upper cone belt and about ¼ in. off the lower cone belt. The upper cone belt is free between the guides but the lower cone belt rubs slightly. The wrapping belt is ½ in. away from the left guide, but only ⅛ in. away from the right guide. If the belts are moved further left to ¾ in. from the end of the cones, everything remains the same except that the wrapping belt is also off the upper cone ¼ in.*

When the belts are at the middle of the cones the wrapping belt is off the upper cone belt ⅛ in. and the lower cone belt ¼ in., but the wrapping belt is in the middle of the guides. The upper cone belt rubs slightly on the right guide and the lower cone belt rubs slightly on the left guide. If the belts are moved to the right until the belts are about 3½ in. from the end of the cones, the wrapping belt and the upper cone belt rub on the right guide and the lower cone belt rubs on the left guide. The sketch shows that the cones differ slightly in diameter but have the same length. Can any POWER *reader explain this condition and suggest a remedy?*—GH

Draft Troubles

Question 2

OUR BOILER PLANT *consists of three hrt boilers set in battery. Each boiler has a 48x16-in. smoke uptake discharging into a 48-in. diameter stack connection which passes over the boiler fronts. We are frequently troubled with poor draft for one or another of the units, especially if some other boiler of the battery is operated with forced draft. How can the drafts be equalized?*—LMR

Pump Priming

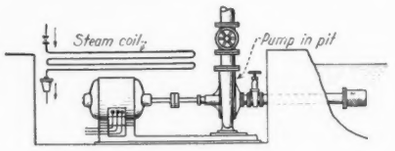
Answers to June Question 1

The Question

THE WATER SUPPLY *for a 10-ton ammonia refrigerating plant comes from a creek about 2700 ft away. In a shack near the creek is a centrifugal pump driven by a 2-hp, 220-volt, 3-phase motor. Current for the motor and lights comes from the plant by an underground cable (No. 4 wire). Every time we operate the plant we have to walk down to the creek and prime the pump to assure suction. In severe weather we have to drain the pump to avoid a freeze-up. Are there ways of priming the pump from the refrigerating plant?*—HHT

Put Pump in a Pit

IN HHT'S CASE, I think the best solution is to place the pump in a pit so that water flows to the suction inlet. A steam coil



could also be placed in the pit to prevent freezing in winter. In this way the pump can be operated from the main plant without priming, or opening and closing drain cocks.

S Vineland, N. J. T DEROSA

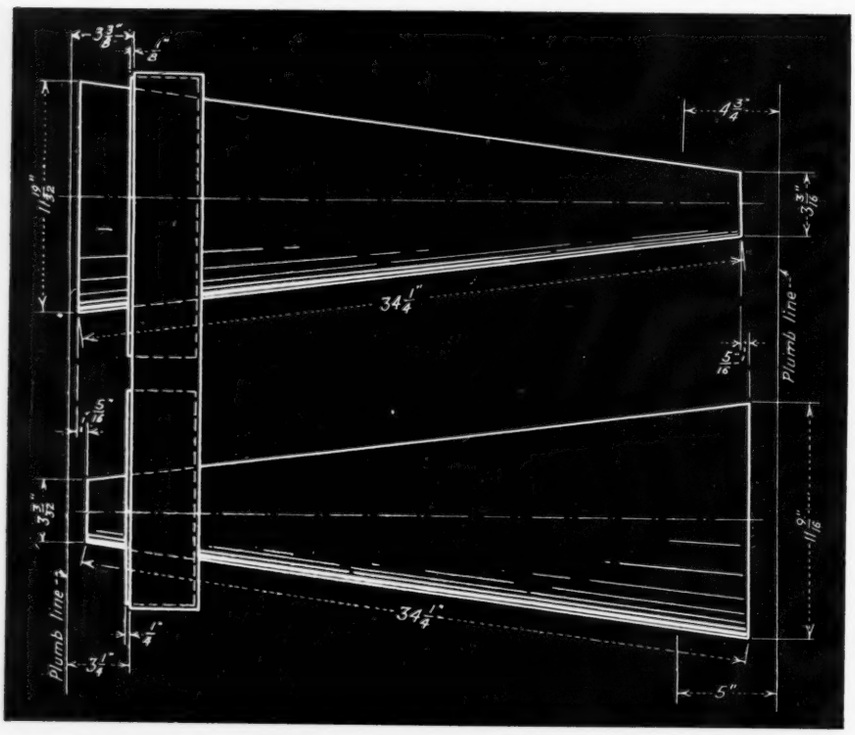
Another Hookup

IN HHT'S PROBLEM we will assume that his pipeline is not much over 2-in. diameter. On this basis, its volume would be equal to about 400-600 gal. of water. If he can find a tank or other suitable vessel around the plant that will hold this quantity of water, he may be able to overcome his difficulty. To prime the pump he must replace the air in the suction line with water. Letting this water flow back into the pump from the plant is just as effective as applying it at the pump.

Starting at the pump suction, he can install a foot or check valve in which a small hole has been drilled in the flap. This hole will allow water to drain from the line after the pump is shut down. Next he should install a float-operated air-vent valve at the top of the vent casing. The float is placed in a small tank filled with water issuing from the air vent.

Putting this system in operation requires that the reserve tank be filled with water each time the pump is operated and before the pump is shut down. The valve to the tank is then closed and the pipe is vented to atmosphere. As air enters the line water will drain through the hole in the check valve back into the creek. As remaining water leaves the pump casing the float chamber will drain through the pump air vent and the entire system will clear itself of water.

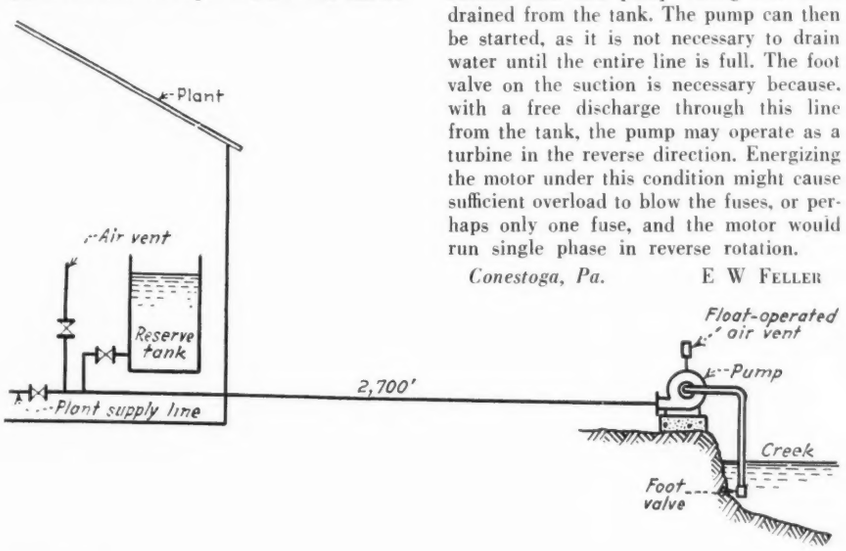
To start the pump, allow water from the reserve tank to flow back into the line. The small hole in the check valve will release any air pocketed in the suction line and the remainder will escape through the pump-casing air vent. After enough water to fill the line has been drained from the tank, the pump can be started by closing its feed switch from the plant. Any air remaining in the pump will be forced out the vent and water reaching the float will close off the



vent. Shutting the reserve tank valve and opening the discharge line will show whether the pump is properly primed. Operation of this system requires that any valve located at the pump remain open at all times. The float-operated air vent can be constructed from an old steam trap in which the leverage has been changed so that it will discharge air instead of water.

A little experience will enable HHT to determine when sufficient water to fill the suction line and pump casing has been drained from the tank. The pump can then be started, as it is not necessary to drain water until the entire line is full. The foot valve on the suction is necessary because, with a free discharge through this line from the tank, the pump may operate as a turbine in the reverse direction. Energizing the motor under this condition might cause sufficient overload to blow the fuses, or perhaps only one fuse, and the motor would run single phase in reverse rotation.

Conestoga, Pa. E W FELLER



Two Suggestions

HHT MUST POSITIVELY PRIME his pump. The following two methods are suggested. The first involves a foot valve. This valve, consisting of a spring-loaded "clapper", should be mounted at the mouth of the suction line. While the pump is in operation, water passing through holds the valve open; when the pump shuts down, weight of the water closes the valve. The suction line and pump casing are thus filled with water when the pump is started again.

If the discharge line remains full of water after the pump has been shut down, a connection can be made between the discharge line and the suction line by a ½-in. pipe. Then, while the pump is operating, water will be continuously bypassed from discharge to suction. After the pump has been shut down, water in the discharge line will maintain a slight pressure in the suction line. Any water lost by leakage will be automatically replaced by water from the discharge line and both suction line and casing will always be full of water.

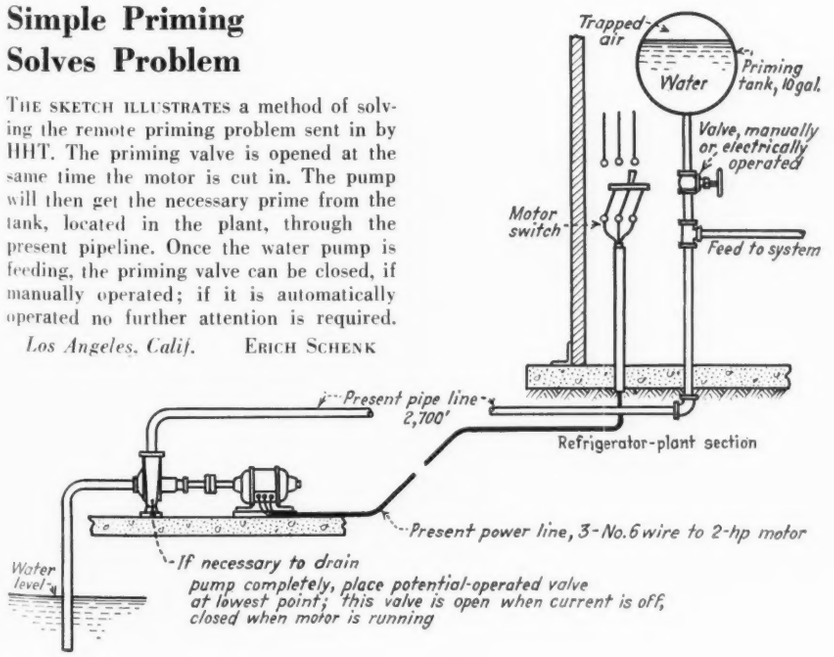
If water at a slight pressure is available at the "shack", connect the water line to the pump casing, preferably near the bottom. A small radiator air valve should be tapped into the upper part of the casing. To prime the pump, open the auxiliary-water-supply valve. Water will fill the pump casing and suction line and the air valve will vent the air. The ordinary air valve will close when flooded with water. A radiator air valve may seem to be a long way from home on a pump casing, but the writer has used this method on several different occasions with moderate success.

New York, N. Y. T G HICKS

Simple Priming Solves Problem

THE SKETCH ILLUSTRATES a method of solving the remote priming problem sent in by HHT. The priming valve is opened at the same time the motor is cut in. The pump will then get the necessary prime from the tank, located in the plant, through the present pipeline. Once the water pump is feeding, the priming valve can be closed, if manually operated; if it is automatically operated no further attention is required.

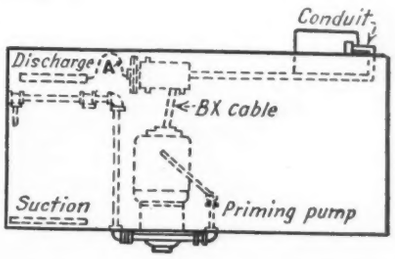
Los Angeles, Calif. ERICH SCHENK

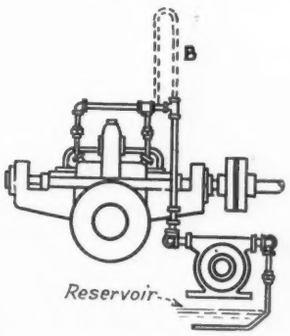

Trapped air
Water
Priming tank, 10 gal.
Valve, manually or electrically operated
Motor switch
Feed to system
Present pipe line 2,700'
Refrigerator-plant section
Present power line, 3-No. 6 wire to 2-hp motor
Water level
If necessary to drain pump completely, place potential-operated valve at lowest point; this valve is open when current is off, closed when motor is running

Vacuum-Pump Priming

A VACUUM PUMP working on water when there is no danger of freezing and on Prestone during freezing weather, can be used to prime the pump. The vacuum unit is connected across the main-pump motor line at a point between the starting switch and the pump motor so that, in starting the main motor, the vacuum pump starts automatically. The sketch shows how the vacuum pump is controlled by a pressure-operated switch in the motor circuit. Switch pressure connections are piped to the discharge nozzle of the centrifugal pump. An adjustable pressure switch can be set so that when the pump is not operating or operating at higher pressures (low capacities), the circuit will remain closed, thus keeping the vacuum pump in operation for priming purposes. The circuit will open when the pump attains the predetermined pressure set for the switch and will stay open in this position as long as pump pressure is maintained.

The pressure connection to the top of the pressure switch is shown in the sketch as *A*





and the suction line for the vacuum pump as *B*. If for any reason the pump loses its prime, pump pressure will decrease, causing the pressure switch to close and bring the vacuum pump into operation to re-prime. Automatic starting and stopping of the main motor can be established easily and inexpensively. A small differential pressure control can be installed some place in the pump discharge line. This control, in turn, operates a motor-control switch which will cut out the motor when pressure builds up (capacity becomes low) or start the motor when pressure in the line becomes less, indicating need for water at the refrigerating

plant. This pressure control can be set for predetermined limits similarly to the pressure control on the automatic priming arrangement.

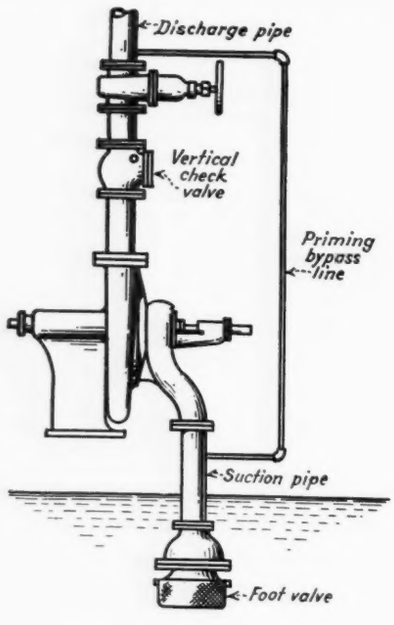
To use Prestone in the priming pump in winter, it is necessary to install a pipe loop of sufficient height to overcome the difference in energy existing between the vacuum created by the pump and atmospheric pressure. This will provide a water leg sufficiently high so that available energy is not able to push water into the vacuum pump. The only available energy comes from the pressure difference between atmospheric pressure at the supply and the vacuum pulled by the pump. Usually, a pump of this type will operate at approximately 14-in. vacuum, so that a 24-25-ft leg would be adequate to prevent water from mixing with the Prestone in the pump. The sketch shows such a leg, with piping dotted.

In order to give an adequate answer to the question of freezing, the details of suction and discharge piping in relation to pump position must be known. Effectiveness of a drain will depend on the type of pump being used and position of the nozzles. If discharge piping is below the centerline, then backflow into the pump at shutoff position can be prevented and the casing will not be kept full of water, since at the suction of the pump there is usually a lift and the nozzles are usually designed so that the casing will empty of its own accord. There are many arrangements which could be made to drain the pump casing, such as a small connection to the drain plug with some type of pressure-operated switch in the line to open and close this valve when necessary.

East Orange, N. J. R C McDONALD

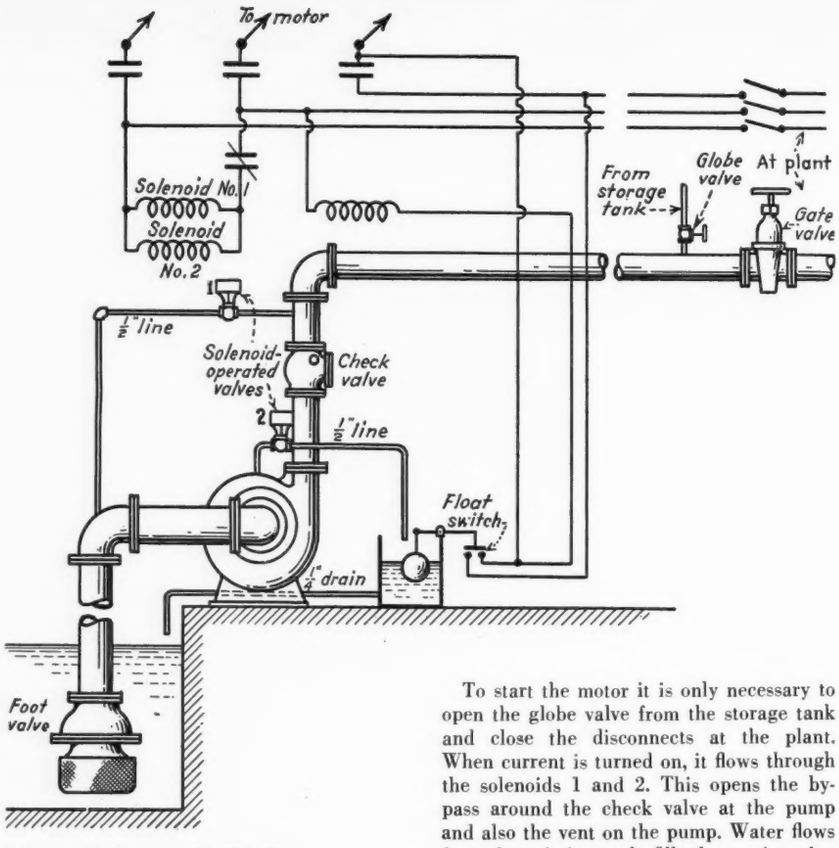
Use Check Valve

HHT's PUMP can be primed from the refrigerating plant by installing a check valve in the discharge and connecting a priming line on the far side of the check valve, as shown in the sketch. When the pump is stopped there will be water in the line from the compressor to the check valve.



To prime the pump, open the gate valve and pet cock on top of the pump casing to vent accumulated air. When water issues from the pet cock in a good stream, start the pump. Be sure that all running parts are lubricated, best done by personal inspection. Likewise, if an attendant is right at the pump when it is started he can detect any unusual noises or other signs of trouble. For this reason, I don't feel that the expense of automatic priming arrangements is justified.

Philadelphia, Pa. W T MULLEN



Use Solenoid Valves

HHT's PROBLEM can be solved by installing valves and switches to do the things he would do if he were in the pump house—namely, pour water into the suction pipe until pipe and pump are filled and water runs out of vent at top of pump. The sketch shows a storage tank at the main plant (an oil drum should be adequate) between the gate valve and the pump.

To start the motor it is only necessary to open the globe valve from the storage tank and close the disconnects at the plant. When current is turned on, it flows through the solenoids 1 and 2. This opens the bypass around the check valve at the pump and also the vent on the pump. Water flows from the priming tank, fills the suction pipe and the pump and runs out the vent into the small tank. This operates the float switch, which energizes the closing coil and starts the pump motor. The circuit through the solenoids is broken when the plunger operates. If the power is turned off, the plunger drops down and the solenoid circuit is again closed and ready to operate when the current is turned on.

Chappell, S. C. E W MCKNIGHT

Reduce Stack Temperature?

Answers to June Question 2

The Question

OUR UPTAKE TEMPERATURE *varies between 700 and 750 F. We have ten 1500-sq-ft, 5-tube, horizontal Dillon boilers which run at approximately 180% rating. The tubes are 3 in. diameter and 16 ft long. We use Perfection hand stokers and our draft is 1 in. The coal we are burning is 1¼-in. nut and slack from the Beckley seam. It has been suggested that we might use tube chokes to advantage to hold the gas in the boiler longer and thus reduce the uptake temperature. Perhaps some* POWER *reader can give us information that will permit correcting the above condition in an inexpensive manner.*—FFM.

Recommends Retarders

THE HIGH STACK TEMPERATURE and a draft of 1-in. implies that gas velocity is too high in these units and that money is being blown up the stack. Even at the high rating there should be sufficient heat transfer to cut down the loss if heating surfaces are kept clean and settings in good condition. The high velocity is partly caused by unrestricted flow through the tubes.

Retarders should be installed without delay. Perhaps FFM calls these "tube

chokes." These retarders are simply sheet-metal strips twisted as shown in the sketch and fitting loosely in the tubes. The function of these in throwing hot gas to the tube heating surfaces is obvious. These retarders are used in many Scotch marine boilers on shipboard and are, I believe, an integral part of the design of the Howden forced-draft system.

Kearney, N. J. GEORGE MCNALLY

Add a Preheater

THE CONDITION reported by FFM could be caused by any one of several things. Are tubes cleaned regularly and does FFM note stack temperature before and after tube cleaning? Are damper regulators used on these boilers and do they work properly, giving the correct settings to suit boiler conditions? Chokes or retarders could be used but I feel they would add to the difficulty of soot removal and thus defeat its purpose.

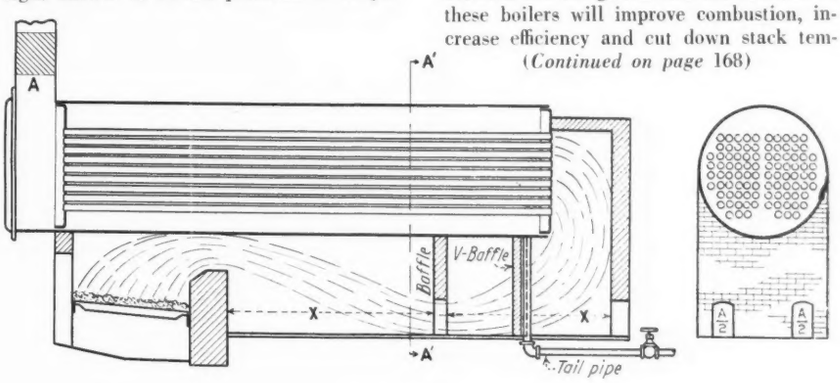
I would try to increase heating surface by installing an economizer or a preheater. This is not inexpensive but may be the right answer to FFM's problem. A couple of coils could be made and inserted into the breeching where gas leaves the boiler. If treated water is used it could be run through these tubes on the way to the feedwater heater, thus utilizing some of the heat in the flue-gas and reducing stack temperature.

Philadelphia, Pa. T F CUNNINGHAM

Install a Baffle

THROUGH LONG EXPERIENCE with hrt boilers, I have found that a baffle placed halfway between the bridgewall and the rearwall of these boilers will improve combustion, increase efficiency and cut down stack tem-

(*Continued on page* 168)



Ejector Avoids Risk of Freezing

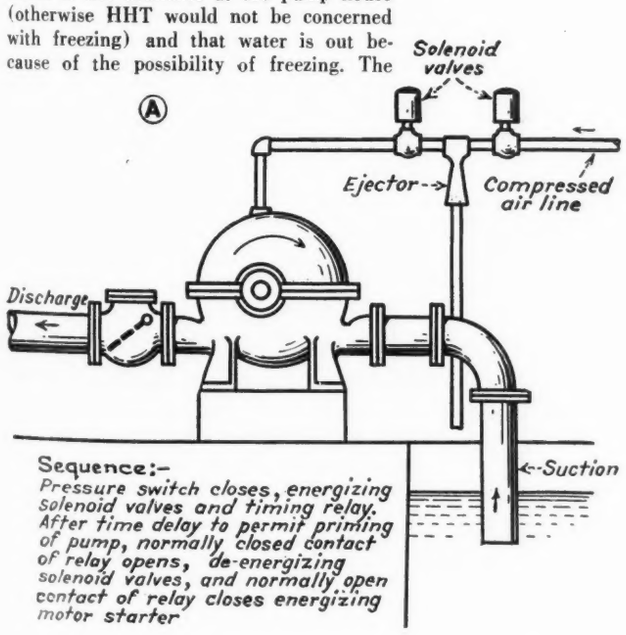
IT APPEARS THAT the solution of HHT's problem must meet two requirements: (1) it must provide remote-control pump priming, and (2) it should not add to the hazard of freezing during severe weather. The second requirement eliminates the possibility of using a priming method involving recirculation of water in the pump or other special water-retaining priming devices in the suction line.

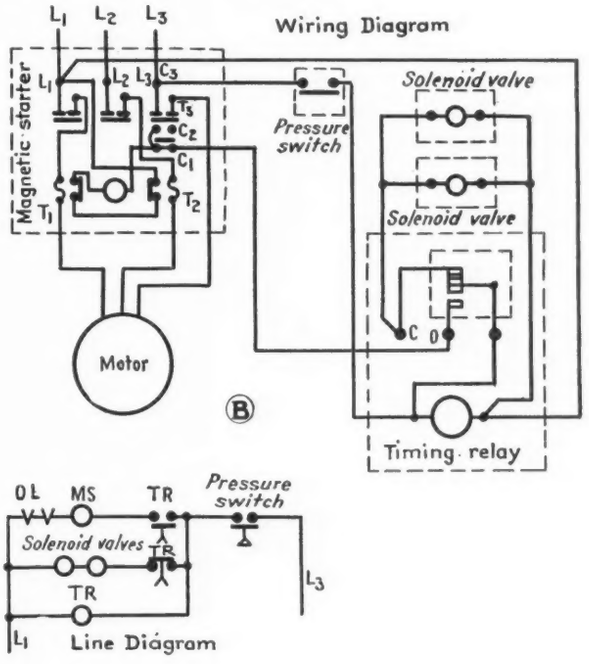
An ejector seems to be the best solution. This can be operated by steam, water pressure or compressed air, but assume that steam is not available at the pump house (otherwise HHT would not be concerned with freezing) and that water is out because of the possibility of freezing. The ejector must thus be operated by compressed air, which if not available at the pump house, can be supplied by a small automotive-type tank-mounted compressor. With the ejector, remote control can be obtained electrically and made either manual or automatic. The electrical devices required are a pressure switch, or equivalent, adjustable time relay with time delay after energization of relay, magnetic motor starter, and two normally closed solenoid-operated valves.

Sketch *A* shows arrangement of ejector and solenoid valves with respect to pump and priming connections; sketch *B* shows the wiring diagram as set up for automatic control with an electrical pressure switch.

The sequence of operation is as follows: Pressure switch closes, energizing timing relay and (opening) solenoid valves. Compressed air flows through ejector, exhausting air from pump. After time delay to permit priming pump, normally closed contact of relay opens, de-energizing (closing) solenoid valves; normally open contact of relay closes, energizing motor starter. The only adjustment of this system is to set the timing relay so that sufficient time will elapse between opening and closing of solenoid valves to permit all air being exhausted from pump and suction line.

Holyoke, Mass. P J EQUI


Solenoid valves
A
Ejector
Compressed air line
Discharge
Suction
Sequence:-
Pressure switch closes, energizing solenoid valves and timing relay. After time delay to permit priming of pump, normally closed contact of relay opens, de-energizing solenoid valves, and normally open contact of relay closes energizing motor starter



How to Figure Heat Mixtures

By PHIL SWAIN

LAST MONTH this page showed how to figure how much steam is needed to heat water in various types of heaters under various conditions. One case covered was where steam is mixed directly with water.

Many other cases of mixing are of practical interest. You can add cold water to hot water to temper it, or hot water to cold to produce a larger quantity of water warm enough for some particular use. You can cool water by adding ice. The engineer who understands the principle of mixtures will have no trouble figuring such problems. All he has to do is remember these two common-sense rules:

Rule 1—Heat in the mixture equals heat in its components.

Rule 2—Heat lost by the hot body equals heat gained by the cold body.

Pick either rule (whichever happens to be more convenient for the problem in hand). Set up the problem and solve it by simple algebra. Here's a demonstration:

Problem 1—What will happen if you mix 4200 lb of water at 190 F with 1250 lb of water at 60 F?

Solution—It is clear that you will have 5450 lb of water at some temperature lower than 190 F and higher than 60 F. To find the actual temperature use either Rule 1 or Rule 2. Let's try Rule 1 first.

Since heats are normally measured above water at 32 F, the heat in 1 lb of water at 190 F is $190 - 32 = 158$ Btu. Similarly, the heat in 1 lb of water at 60 F is $60 - 32 = 28$ Btu. Then, by Rule 1,

Heat in the mixture = Heat in its components

Heat in 5,450 lb = Heat in 4,200 lb plus heat in 1,250 lb

Heat in 5,450 lb = $(4{,}200 \times 158) + (1{,}250 \times 28) = 663{,}600 + 35{,}000 = 698{,}600$ Btu

Heat in 1 lb of mixture = $698{,}600 \div 5{,}450 = 128$ Btu

To get final temperature of the mixture add 32 degrees, which gives 160 F.

Problem 2—How much water at 70 F must be added to each thousand pounds of water at 205 F to temper it to 160 F?

Solution—Here Rule 2 will be convenient. Use the letter C to represent the unknown quantity of cold water required. First, 1000 lb of water are cooled from 205 to 160 F, a heat loss of $1000 \times (205 - 160) = 45{,}000$ Btu. Second, C lb of water heated from 70 to 160 F, a heat gain of $90 \times C$ Btu. Then, by Rule 2,

Heat gained by cold water = Heat lost by hot water

$$90C = 45{,}000$$
$$C = 45{,}000 \div 90 = 500 \text{ lb}$$

Therefore add 500 lb of 70-F water to each 1000 lb of water at 205 F to get 1500 lb of 160-F water.

Problem 3—How much ice will be required to cool 800 lb of water from 80 F to 40 F, assuming that all the ice is completely melted in the mixture?

Solution—To melt 1 lb of ice at 32 F into water at 32 F requires 144 Btu. If the ice melts and then rise to 40 F, the heat it takes up will be $144 + 8 = 152$ Btu per lb. The water is cooled 40 degrees and therefore loses a total of $40 \times 800 = 32{,}000$ Btu. Then, by Rule 2, letting I represent the number of pounds of ice required:

Heat gained by ice = Heat lost by water

$$152I = 32{,}000$$
$$I = 32{,}000 \div 152 = 210 \text{ lb of ice required}$$

Problem 4—What will be the final temperature of 200 lb of water at 60 F, if it is used to quench 100 lb of iron at 900 F?

Solution—The specific heat of iron and steel is very close to 0.1, meaning that they require only 0.1 Btu to raise the temperature of 1 lb one deg F. When the quenching is over, and a steady state is attained, both iron and water will be at same unknown temperature T.

Then the heat lost by the iron will be $100 \times (900 - T) \times 0.1 = 9000 - 10T$. Heat gained by the water will be $200 \times (T - 60) = 200T - 12{,}000$. By Rule 2:

Heat gained by water = Heat lost by iron

$200T - 12{,}000 = 9{,}000 - 10T$, or

$$210T = 21{,}000$$
$$T = 21{,}000 \div 210 = 100\ F$$

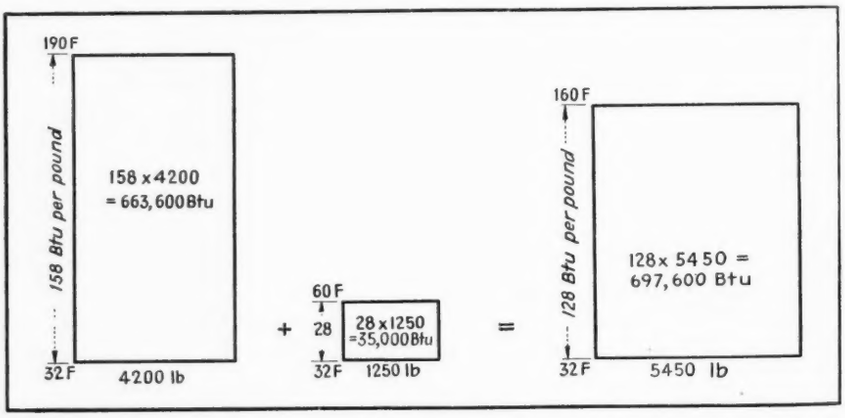


Fig. 1—Illustrating Problem 1: 4200 lb of water at 190 F, mixed with 1250 lb water at 60 F, gives 5450 lb mixture at 160 F

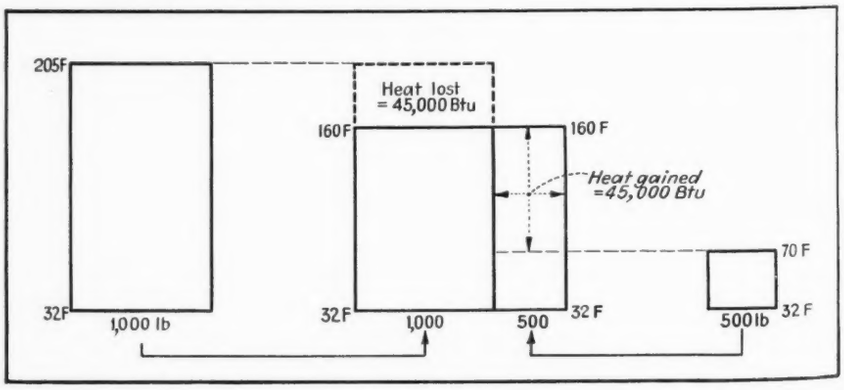


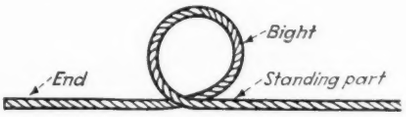
Fig. 2—Illustrating Rule 2 and Problem 2: Hot water cooling to 160 F gives up 45,000 Btu which equals gain of cold water in rising to 160 F

HOW TO TIE KNOTS

EVERYBODY from sailors to housewives uses rope in one form or another; power operators find it very handy for odd jobs around the plant. Most people, however, forget that a rope is actually only as strong as its attachment to another rope or to fixed or movable objects, no matter how strong it is under direct pull.

In bending a rope sharply, either around a small pipe, bar or ring, or around itself, individual fibres are strained and the net strength of the rope at such a bend is reduced by just that amount. In other words, every knot reduces rope strength, in some cases as much as 50%.

The following diagrams show how to tie various knots correctly. October POWER will show how to make and apply the common hitches. Data and diagrams by W Elwood Rossnagel, safety engineer, Consolidated Edison Co of N. Y., Inc.



1 **PRINCIPAL PARTS OF A KNOT—These are the framework on which any knot is tied**

2 **OVERHAND—Passing the end through the bight of Fig. 1 produces this familiar knot**

3 **SQUARE—Perhaps most common of all is the square knot, used to join two ropes or cords. Note that the end and the standing part of the same rope lie together while the bight of the other rope passes either over or under *both*. This knot is safe and dependable if ropes are same size and dry, but even then rope strength is only about 50%**

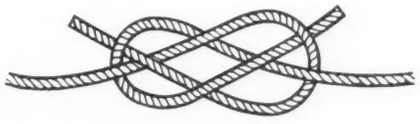
4 **GRANNY'S—This is a square knot tied improperly. Note that the bight does not go either over or under *both* parallel parts of the knot. This knot is unsafe and should never be used**

5 **SURGEON'S—In tying up a compressible bundle, such as overalls for instance, it is often difficult to keep the first half of the knot from slipping while the second half is being tied. Solution is the surgeon's knot, in which an extra turn is taken in the first half of a square knot**

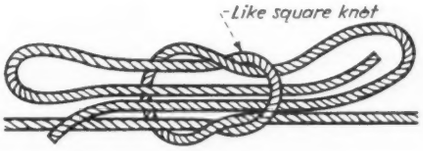
6 **SHEET BEND—Where wet ropes, or ropes of different sizes are to be joined, this knot proves more dependable than the square knot, but it will jam under strain and is consequently difficult to untie. The same knot, when used to join the cords in a net, is called a Weaver's Knot**

7 **SHEET BEND IN EYE SPLICE—When a small rope is used to reeve a larger rope or steel cable with eye splice through pulley blocks or sheaves, this adaptation of the sheet bend is used**

8 **HAWSER BEND—Prime application is for joining large hawsers. This knot is easily untied**

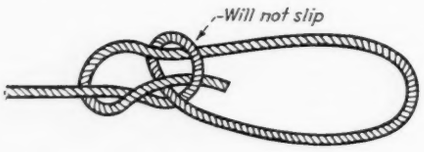


9 **CARRICK BEND—Same application as Fig. 8**

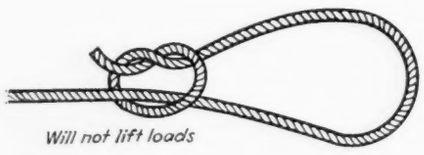


10 **DOUBLE BOW—As in the square knot, the bight must pass over or under all the parallel parts to be non-slip. Primary application is for joining small cords**

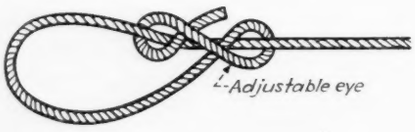
HOW TO TIE KNOTS



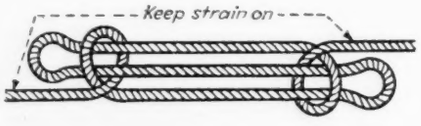
11 **BOWLINE—The rigger's standby appears difficult but really is quite easy. First, make a simple loop in the rope some distance from the end, then weave the end under and over the parts of the rope as you pass it through the loop, around the standing part, and back through the loop parallel with itself. This forms an eye that will not slip, yet which does not jam. It is readily untied after pressing backwards on the loop going around the standing part. Knot efficiency is about 60%**



12 **SLIP—This knot, commonly used on small cords, is not dependable and should never be used to lift loads**

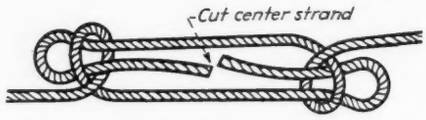


13 **BUNTLINE—This knot does the trick where an adjustable eye is required. If a running noose is needed, you can use a Bowline (Fig. 11); pass the standing part of the rope through the eye**

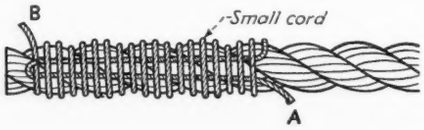


14 **SHEEPSHANK—This knot, used to shorten a rope temporarily without cutting it, is very satisfactory provided strain is kept on the rope**

15 **KNOTTED SHEEPSHANK—Where strain is intermittent, this knot is more dependable than the one shown in Fig. 14**



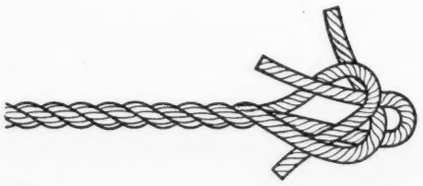
16 **CUT SHEEPSHANK—This knot is sometimes used by steeplejacks for getting down from the top of a newly built stack not equipped with a permanent ladder. After (and if) the jack gets down safely, he jerks the rope and rolls loop up in it until the Sheepshank comes apart and the rope falls to the ground, leaving only a foot of rope at the top. Note: This is not recommended as safe practice**



17 **WHIPPING—This is the ideal way to prevent strands from untwisting or unlaying. First, a small cord or rope yarn is formed into an elongated "U" on the rope. Then, beginning at *A*, wind this cord tightly around the rope (the drawing shows the turns separated for clarity) until point *B* is reached. Then pass end *B* through the loop as shown, and finally pull end *A* until the interlocked loops are midway under the lashing. Complete the job by cutting off the two protruding ends of the cord**

18 **FIGURE 8—Commonly used to secure the strands of a rope**

19 **WALL—Use this knot to get a more permanent job than possible with Fig. 18 and immediately on top of it put a Crown Knot, Fig. 20**



20 **CROWN—This knot looks like it would take three hands but a little practice will change your mind**

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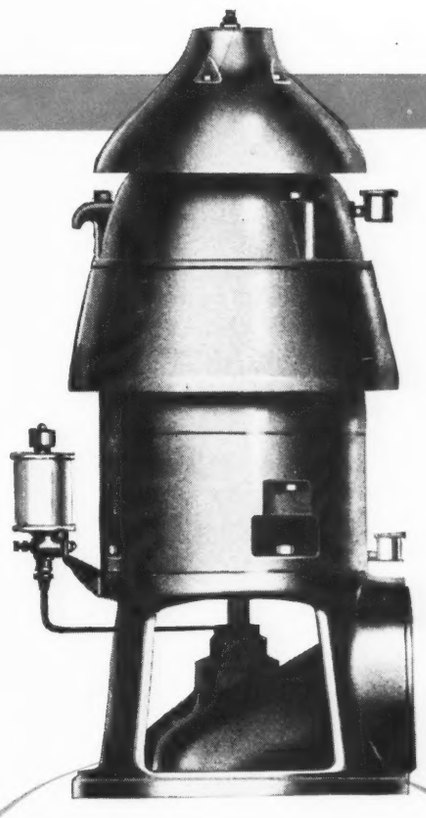

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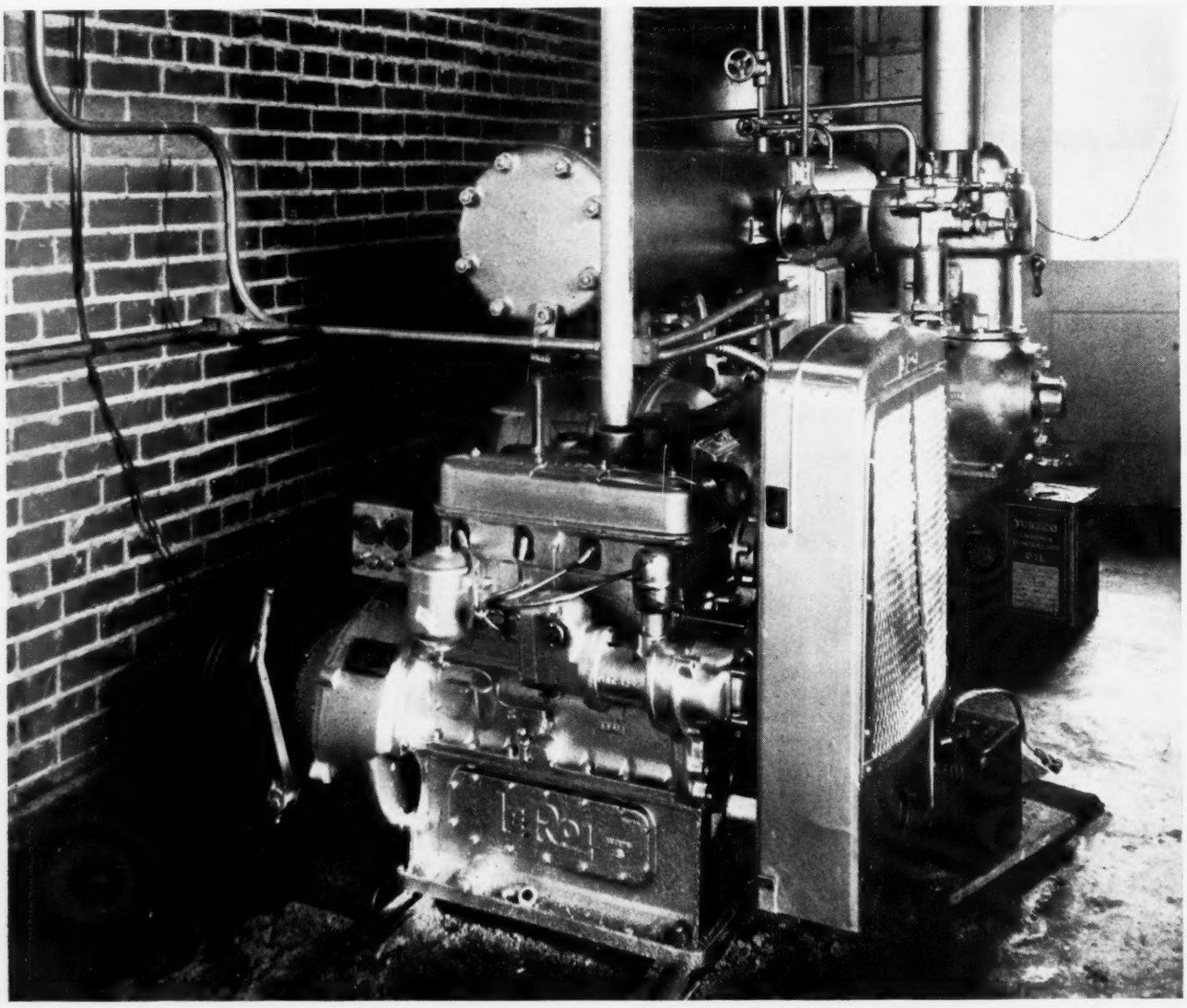
Engines for Locker-Plant Power

Orville Adams reports experience at Texas plant and discusses possible applications of diesel and gas engines in the rapidly growing locker-plant industry



Gas-engine unit drives refrigerating compressor at Keen Frozen Food Locker Co, Corsicana, Texas

► RAPID GROWTH of the new locker-plant industry throws the spotlight on a field where oil and gas engines can, in many cases, affect substantial power-cost savings. Experience at a typical Texas plant indicates the nature of the load and the requirements for satisfactory operation.

But first, just what is a locker plant? Briefly it's a sort of retail cold-storage and food-processing plant. Farmers and citizens of small towns bring in meat and garden produce; the locker plant prepares the food, freezes it, and stores it, in individual lockers, for future use by the customer. In most cases in the past, farmers had to depend on makeshift curing rooms in local ice plants and no effort was made to encourage use of such facilities by consumers.

The first locker plant went into service in Texas in 1937; by last year the number of plants had grown to 50; today there are more than 100 plants in operation with many more in the planning and construction stages. Typical of the new industry is the Keen Frozen Food Locker Co. at Corsicana, Texas, which started operation in October, 1938, under the management of H B Walker. In March, 1940, Mr Keen purchased the plant and expanded the processing,

(*Continued on page* 116)

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Engines for Locker-Plant Power

(Continued from page 114)

quick-freezing and locker-rental service, including a complete and scientifically controlled meat-curing room. Under one roof it now offers lockers for rent, and facilities for purchasing, processing, freezing, and storage. Meats, particularly pork, may be cured by modern packing-house methods and then stored by customers in special pork and meat vaults.

The plant was originally designed to operate on purchased power, with 540 lockers, and additional space for refrigeration and commercial meat chilling, egg storage, and pork curing. The plant started with 300 lockers rented; now more than 400 are rented the year around and it is expected that maximum capacity will be utilized within the present year. Hogs and calves are slaughtered regularly and processed the year around; the meat curing and handling requires a regular crew.

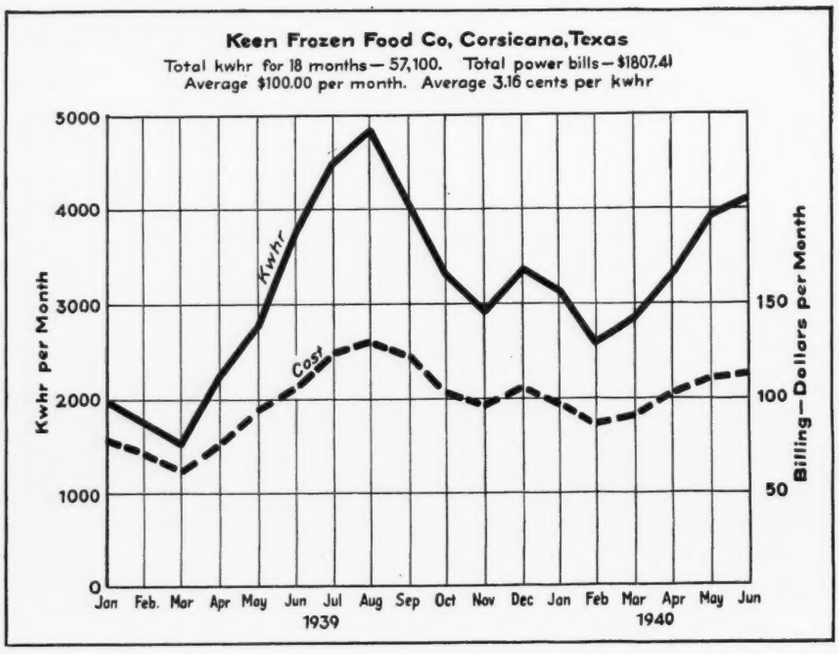
Study of plant operation with a view to reducing costs focussed attention on the power situation. Power and light requirements exceeded 40,000 kwhr per year, at an average rate of more than 3¢ per kwhr. A 15-hp motor, V-belted to a 5x5-in. York ammonia compressor, constituted the bulk of this load. The facts indicated savings could be made by private generation.

Gas-Engine Unit

In September, 1940, a 4x4-in., 4-cyl LeRoi gas engine replaced the motor as the compressor drive. This unit develops approximately 20 hp at governed speed but the average load is about 10 hp for normal operation. Gas consumption runs about 10-11 cu ft of natural gas per brake hphr; gas costs $26 for 50,000 cu ft and all excess above this costs $.31 per M cu ft.

Purchased electricity still supplies office and work-room lighting, electrically operated meat grinders and power saws in the butcher shop. The engine is manually started; electric controls automatically cut off the compressor when sufficient refrigeration has been supplied.

The engine, which has 201 cu in. piston displacement and operates at 900 rpm, is equipped with an Ensign natural-gas carburetor, Delco battery-starting equipment, and radiator cooling. A Twin-Disk clutch, now hand-operated, connects the engine and drive pulley which is V-belted to the compressor. The engine mounts the usual gages, thermometers and water-circulating pump and also an edge filter for lube oil.



Load and power cost curves for 18 month's operation in a typical locker plant

The accompanying chart shows the kwhr consumption by months and the amounts billed. The cost per kwhr averages about 3.14¢ for the first 12 months and about 3.16¢ for the 18 months before the engine was installed. The total power bill for this period was $1807.40. This included current for lights and small motors; at present, with the engine driving the compressor, the current for these purposes costs about $25 per month. Natural gas for compressor operation costs about $25 per month also. At very little additional expense for fuel, an engine-generator set would handle the entire load, making further savings over the present scheme. Experience indicates that the ideal power plant for this operation would comprise duplicate generating units of ample capacity to afford sufficient standby reserve and arranged so that the two units could be paralleled for peak operation as the load increases.

Automatic operation is highly desirable in locker plants. The records of the Keen plant show that during a 15-month period, with the compressor motor-driven and electrically controlled, the compressor operated a total of 5158 hrs or an average of 344 hrs per month. The compressor started and stopped approximately 2760 times or an average of 184 times per month. Consideration has been given to the practicability of using fluid drive for direct compressor operation, and to completely automatic electric generation by engine-driven units.

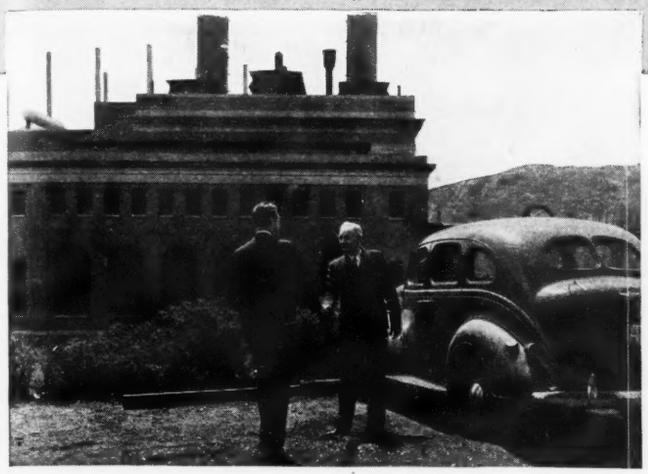
The average locker plant involves a demand of 15-25 kw, depending on the size of the operation. There are now more than 3000 locker plants in the country, most of them small. A number of diesel-electric installations have been reported, as well as plants with engines operating on natural gas and butane. The nature of the load indicates definite possibilities in most areas for automatically controlled engine units.

A study of the Keen plant indicates that requirements for both light and power could be generated by diesel or gas-engine sets for less than 1¢ per kwhr, including all operating expenses, together with fuel, lubricating oil, repairs and engine maintenance. Compared with power rates in many areas, this indicates possibilities of a payout in 3 to 5 years.

To reduce initial investment, some operators are seriously considering installing a complete generating plant with standard heavy-duty diesel or gas engines, arranged for automatic operation, and using converted automotive engines for cheap breakdown insurance. There is, of course, no comparison between the modern heavy-duty engine and the converted unit when service life and upkeep are concerned, but it is felt that the cheaper engine would serve standby requirements satisfactorily. This solution seems to offer possibilities where original investment must be cut to the bone.

The Mystery of the Missing Vent

Inlet end tube failure faced this coast power plant. From investigations, failure was apparently due to air being entrained in the circulating water. Plant blue-prints, however, provided no clue to this. A new and more expensive alloy seemed indicated.



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METALS A complete follow-up, by Scovill research, in this case, testing the water and examining metals, established that the plugged vent alone caused the trouble. No more worry!

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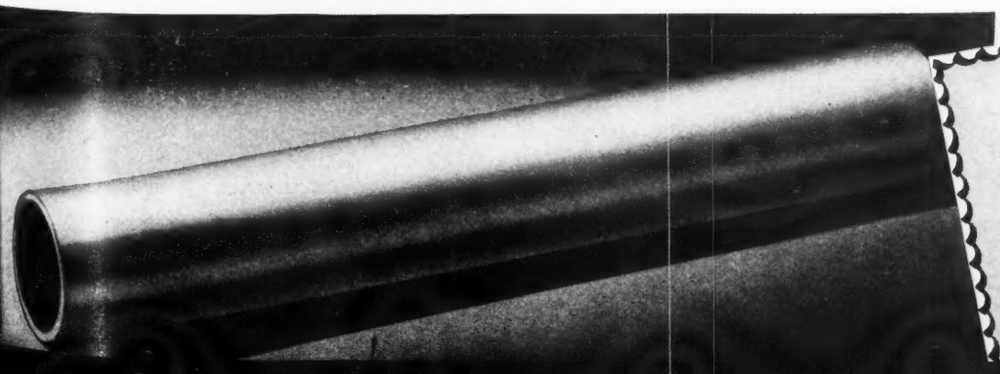

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How to Figure Steam-Engine Drive

E J Vonachen outlines advantages of small steam engines for auxiliary drives and shows how to compare costs with other driving methods

PROPERLY APPLIED, steam engines offer many advantages as drives for power-plant auxiliaries or for process equipment of all kinds, such as refrigeration compressors, pumps, mills, conveyors, blowers and ventilating fans.

Most small steam engines operate at moderate speeds suitable for direct connection to many machines. Speed reductions, as for stoker drives, or speed increases, for fans, can be easily effected by flat or V-belts or by gearing. Speed adjustment over a wide range can be simply arranged; control may be manual or automatic. Previous articles (POWER, March, April, May, 1937) discussed methods of control in detail.

Wide Range of Conditions

Small engines can be obtained to meet a wide range of steam conditions: from 20 to 400 lb pressure and up to 750 F at the throttle. Where desired, engines can exhaust to vacuum, but in most cases exhaust is utilized and the engine operates at a backpressure from a few lb to 150 lb. High starting torque and large overload capacity along with ability to start quickly are other useful engine characteristics.

The small steam engine, as built for auxiliary or process-equipment drive, features simplicity in mechanical construction, which reduces maintenance and eliminates need for skilled operation. This same simplicity also contributes to long life and reliability.

All these factors indicate the desirability of considering the steam engine when auxiliary and process-equipment drives are being selected. The following paragraphs give the information necessary and the method to be followed in comparing, economically, the steam engine with other drives.

The first step involves determining power requirements and general characteristics of the equipment to be driven. This will fix the size of driving unit required and indicate the average power consumption. Performance data of the driven equipment will also indicate the method to be used in connecting the driver; that is, whether speed reduction or increase is required, and nature of the control to be used.

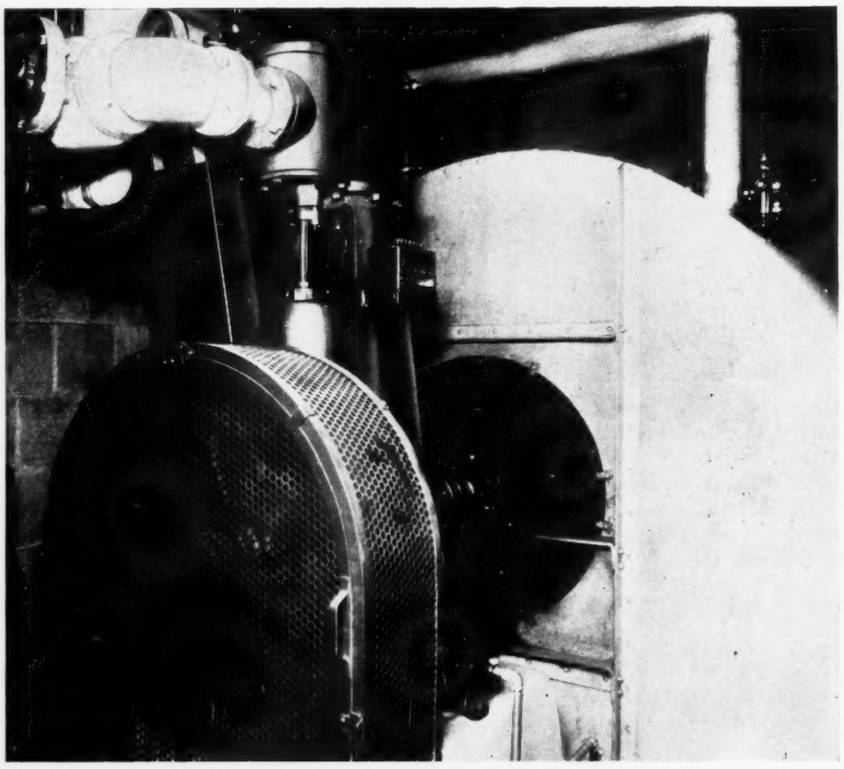

Fig. 1—Vertical steam engine driving draft fan

It is possible that these preliminary studies may produce the answer without any economic analysis. For example, need for close speed variation over a wide range might make application of a motor difficult and expensive; need for extremely high rotative speed might rule out an engine; remote location of equipment with need for long pipelines might rule out either a turbine or an engine, and so on.

Assume, however, that all three likely methods of driving (engine, turbine or motor) meet the requirements. The next step is to estimate operating costs. From the manufacturer's data on the driven unit, figure the power requirements. In most cases an average will do, but if the load varies considerably, it may be necessary to figure the number of hours operation at each load. With the necessary power consumption data, go into the curve of Fig. 2 to find steam consumption of the engine. Similar curves will give steam consumption for a turbine, or current consumption of a motor.

If no way of utilizing exhaust is available, multiplying steam consumption by steam cost will give the power cost for the engine. However, in most cases it will prove possible to utilize part or all of exhaust. To allow for this it is necessary to figure how much of the heat in the throttle steam is used by the engine and how much is available in the exhaust. With the aid of a steam table, this can be easily figured.

Assume that the engine operates at 200 lb, saturated; the heat content of throttle steam is found to be 1199 Btu per lb. If the average temperature of feedwater to the boiler is 180 F, its heat content will be 148 Btu so the heat supplied by the boiler to each lb of steam is 1051 Btu. This is all chargeable to the engine unless some of the exhaust is utilized.

Whether or not part or all of the

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How to Figure Steam-Engine Drive

(Continued from page 118)

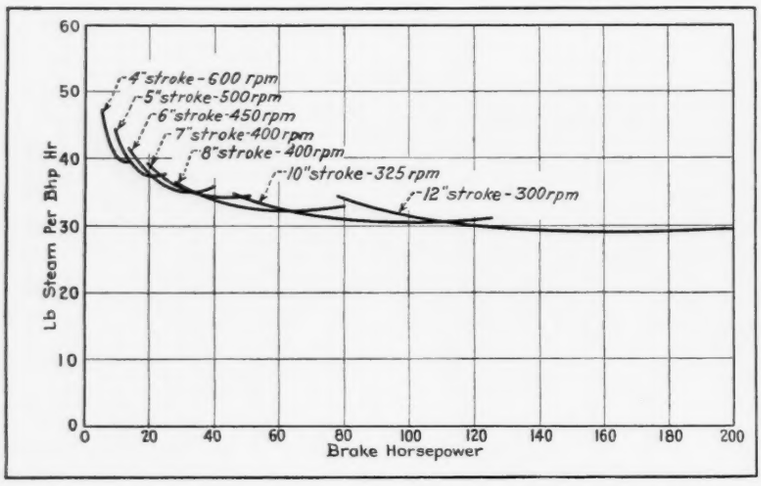

Fig. 2—Steam consumption of typical small steam engines

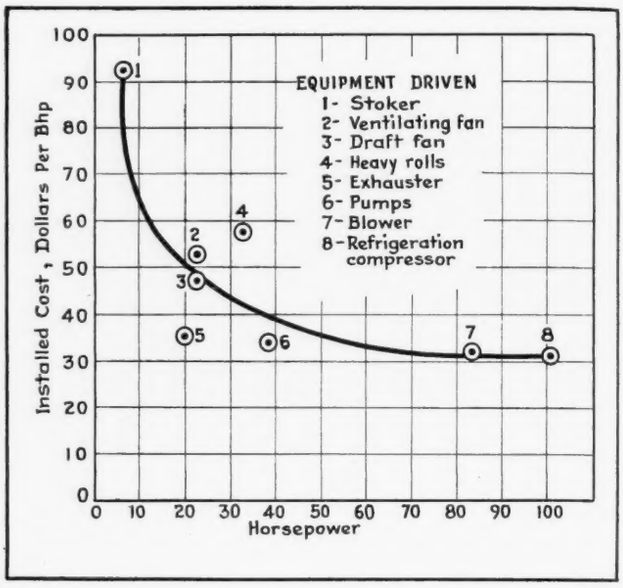

Fig. 3—Installed cost of auxiliary-drive engines: includes foundation but no piping or speed-changing equipment

exhaust steam from the proposed engine can be used depends on local plant conditions. In most cases the simplest way to find out is to look around for steam needs supplied at present with live steam that could be supplied equally well with low-pressure exhaust. This means checking the feedwater-heating setup, the service-water-heating system, the building-heating system and all the process-steam systems.

If live steam is being used where exhaust would do as well, see how the amount of steam available from the proposed auxiliary engine matches this demand, and also see if the demand exists at times when exhaust is available. Exhaust available only during night hours doesn't do any good for a heating load on only in the day time.

Let's assume that all the exhaust can be utilized. To figure how much steam is chargeable to the engine, determine the backpressure to be carried. We also have to know quality of the exhaust (percent of dry steam present). This figure can be obtained from the steam-engine builder. Let's assume that the quality is 95% in this case. To find heat content of the exhaust, consult the steam tables. For steam at 5 lb heat content of the liquid will be 196 Btu and latent heat of vaporization will be 960 Btu. Heat content of the exhaust is found by taking 95% of 960 (latent heat of vaporization) and adding to this the heat of the liquid. This amounts to $0.95 \times 960 + 196 = 1108$ Btu.

Heat chargeable to the engine is the difference between heat content of the throttle steam and heat content of the exhaust, or $1199 - 1108 = 91$ Btu. To find what percent of the heat added in the boiler this is, divide 91 by 1051, which is 8.7%. Thus it can be said that the engine uses 8.7% of the steam supplied to it from the boiler.

Steam Consumption

Next, determine steam consumption of the engine at the given load using Fig. 2. This is typical for small engines; if greater accuracy is desired, secure a guaranteed steam consumption curve for the engine you propose to use. Assume that the engine in question is to be operated at 100 hp for 3000 hr per year, and that the steam consumption at 100 hp is 3300 lb per hr. Amount of steam chargeable to the engine is $3300 \times 3000 \times 0.087 = 861{,}300$ lb per year. At, say, 40 cents per 1000 lb, steam cost is $345.

Now, suppose only 50% of the exhaust from this engine can be used. Obviously steam cost would be higher. Half of the 3300 lb per hr going to the throttle would be wasted to atmosphere and for this amount, it would be necessary to charge $1650 \times 3000 \times 0.40 = \$1980$. Of the remaining half, 8.7% is chargeable to the engine, so we get $1650 \times 3000 \times 0.087 \times 0.40 = \$172$. Thus, the total steam cost would be $2152.

Having found the steam cost, it is necessary to estimate other operating costs. Lubrication may be figured at roughly $1.00 to $2.00 per hp per year. Maintenance may be figured at 2% of the engine cost, per year. In most cases, no extra labor is required to operate an auxiliary-drive steam engine, or for any other driving equipment.

The above method of establishing operating costs will fit the case of a steam turbine equally well, although steam rates and other factors will be different. In the case of a motor, of course, it is necessary to find its power consumption at the rated load and then to apply the cost of electric energy, whether purchased or privately generated.

Having established the costs for each type of driver under consideration, it is necessary to set up the installed costs for each. The chart in Fig. 3 shows actual costs for eight engine installations and the curve can thus be taken as a fair average of such costs. Similar data should be obtained on motors and turbines to make possible a complete comparison.

If one type of drive is lowest in respect to both operating and installation cost, it is obviously the right equipment for the job. Usually, however, it will be found that units high in first cost will be low in operating cost and vice versa. For example, assume that the steam engine shows a lower operating cost than the motor, but its first cost is higher. It is then necessary to figure the difference in operating costs and in first costs. If the saving in operating cost due to use of the engine is sufficient to pay out the difference in first cost in a reasonable time, then the engine should get the call. The time of pay out depends on company policy but many industrial companies require a pay out in 5 years or less.

THE disadvantages of boiler scale are too well known to require detailed description. External methods of softening, while beneficial to many waters, seldom provide a complete answer. Internal treatment, to follow the external, is recommended by Betz engineers only after a thorough study of the individual case. No two treatments are alike in every detail; each is a separate problem. Betz engineers are not required to rely on phosphates alone to solve these problems, but have access to every known chemical, including the Reactive Organic Colloids developed by Betz research.

The Betz organization is devoted exclusively to consultation, research and supervision in the field of water conditioning... from plant design to plant operation. In the solution of any and all water problems, Betz renders a complete service.

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POWER LINES

FPC Projects Power Capacity to 1946

Scheduling turbine manufacturers to the hilt for the next five years, the Federal Power Commission recently announced names and locations of 108 steam plant extensions totalling 8,609,000 kw to be installed by utilities and three government steam plants aggregating 255,000 kw. Also, 66 hydroelectric projects will plan for 4,890,000 kw in a program which calls for construction of seven storage reservoirs without power facilities.

This program of over 13 million kw includes only a few units of 6,361,000 kw already ordered by utilities in the eighteen months ended June 30. Manufacturing capacity for maximum output of turbine and generator builders is estimated at an "annual production of approximately 2½ million killowatts of new steam and one million kilowatts of new hydro generating-station units." With the cooperation of utilities in placing orders an orderly priority arrangement for the necessary materials can be worked out.

FPC estimates that 20 million kw will be required for defense needs when the peak of the armament building program is reached. Of this something more than half must be supplied by diversion from normal uses and is expected to cause extensive changes in present non-defense power use.

A complete analysis of this program will appear in POWER's September issue, "Power for the Battle of Production."

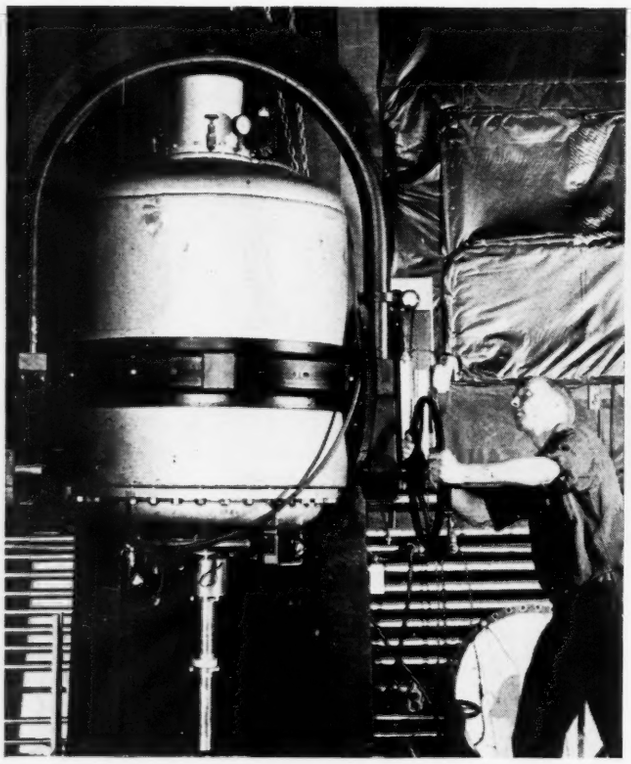
Copper Conductor Standards Accepted

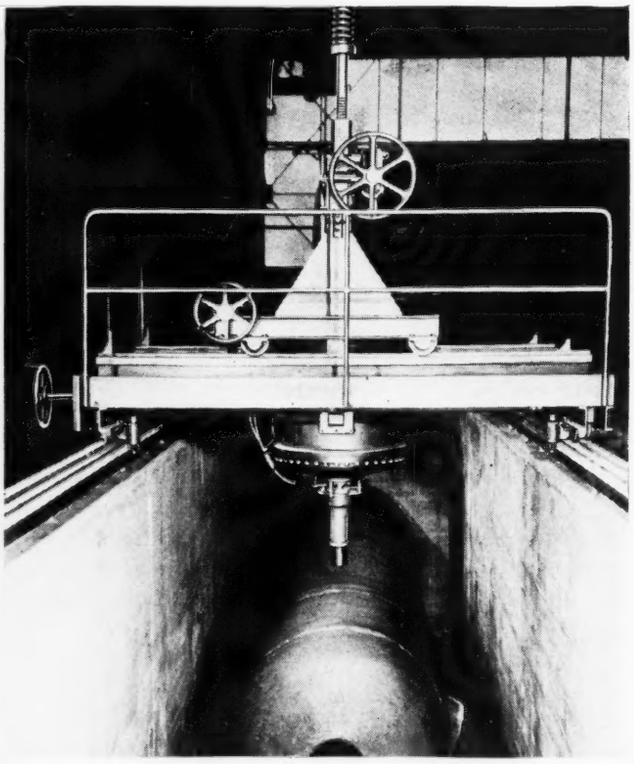
The Simplified Practice Recommendation for Copper Conductors for Building Purposes, recently proposed as a means of facilitating the national defense program by conserving copper, has been accorded required degree of acceptance by those interested, and has been approved for promulgation as of July 1, 1941, according to an announcement of the National Bureau of Standards of the Department of Commerce, U. S. Government.

This recommendation, to be known as R180-41, lists 17 stock sizes of copper conductors in the range from No. 14 (American Wire Gage) to 500,000 circular mills, and recommends that sizes

(*Continued on page* 186)

MILLION-VOLT X-RAY SPEEDS PRODUCTION OF BOILER DRUMS





Application of million-volt X-ray equipment developed in the General Electric research laboratories to the inspection of welded boiler drums up to 8-in. thickness was recently announced by Babcock & Wilcox and Combustion Engineering Companies. Previous units of 400,000 volts required 3½ hours per foot of weld inspected of 4½-in. metal; the new machines reduce this time to 3 minutes.

The shock-proof self-contained unit at left above is a duplicate of the machine being installed at the Chattanooga boiler shops of Combustion. A separate building with 18-in. concrete walls insures protection against the escape of stray X-rays. The tube itself, drawing three milliamperes at 1,000,000 volts, is contained in a grounded steel tank employing compressed Freon insulation and produces energy equal to $90,000,000 worth of radium.

At right is shown the concrete-lined pit at the Barberton Plant of The Babcock & Wilcox Co with a boiler drum in position supported on motor-driven trunnions. The X-ray tube and transformer run over the weld with the rays directed downward providing a maximum of protection for the operator. The special carriage is adjustable vertically, horizontally and laterally and the tube can be swung at an angle.

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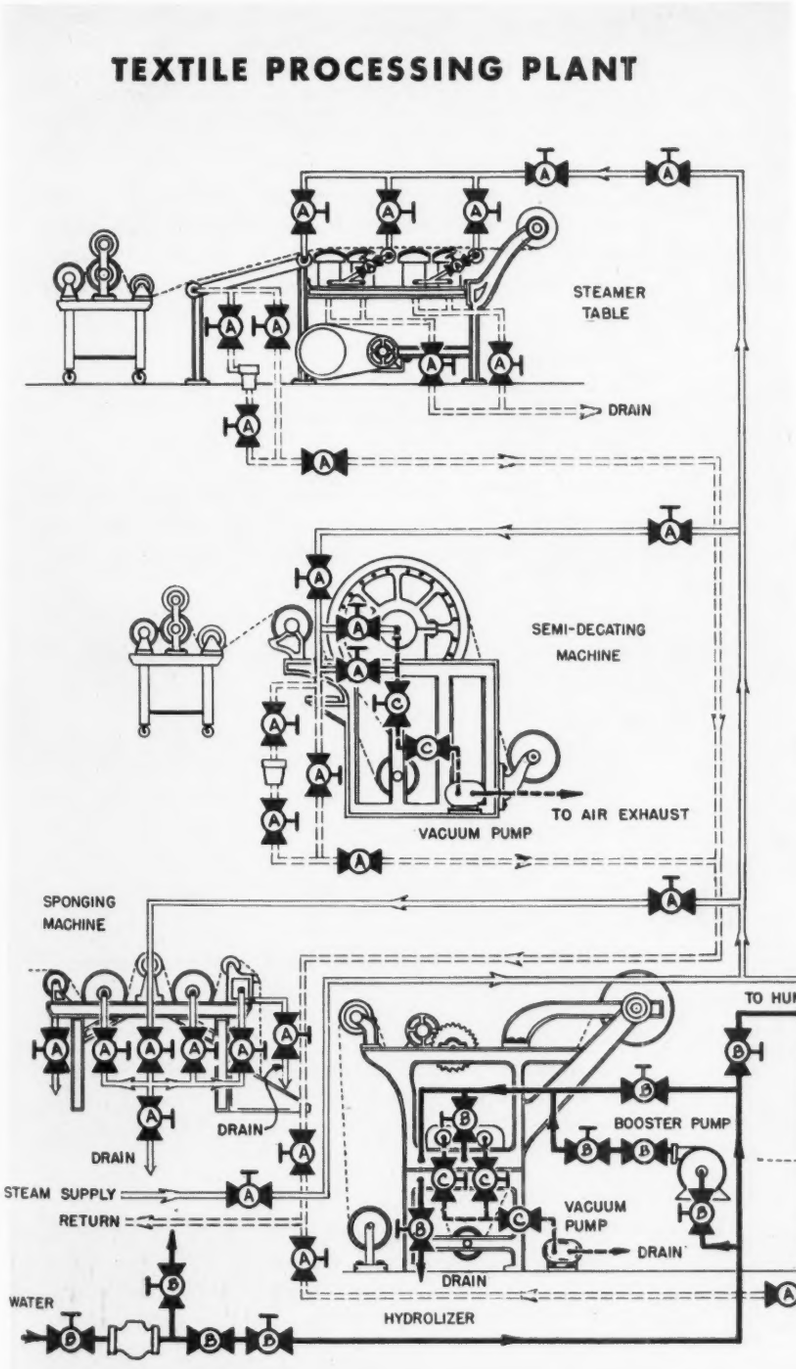

REFERENCE CHART FOR JENKINS FIGURE NUMBERS

		Standard	Medium	Extra Heavy
A	STEAM LINES GLOBE	BRONZE 106A Sc. Disc Type IRON 612 Sc. Regrinding 613 Fl. Regrinding 141 Sc. Disc Type 142 Fl. Disc Type	BRONZE 750 Sc. Regrinding 950 Sc. Regr.-Renew 956 Sc. Regr.-Renew Plug IRON 918 Sc. Regrinding 919 Fl. Regrinding 774 Sc. Disc Type 775 Fl. Disc Type	BRONZE 801 Sc. Disc Type 1140 Sc. Regrinding 1150 Sc. Regr.-Renew 970 Sc. Regr.-Renew **976Sc. Regr.-Renew** **988 Sc. Regr.-Renew** IRON 922 Sc. Regrinding 923 Fl. Regrinding 162A Sc. Disc Type 162 Fl. Disc Type
	GATE	BRONZE 47 Sc. Travel Spindle 49 Sc. Travel Spindle 370 Sc. Non-Rising 368 Sc. O.S. & Y. 670 Sc. Non-Rising 672 Sc. O.S. & Y. IRON 325 Sc. Non-Rising 326 Fl. Non-Rising 650 Sc. O.S. & Y. 651 Fl. O.S. & Y.	BRONZE 270 Sc. Non-Rising 275 Sc. O.S. & Y. IRON 251 Sc. Non-Rising 255 Fl. Non-Rising 277 Sc. O.S. & Y. 253 Fl. O.S. & Y.	BRONZE 280 Sc. Non-Rising 282 Sc. O.S. & Y. IRON 203A Sc. Non-Rising 203 Fl. Non-Rising 204A Sc. O.S. & Y. 204 Fl. O.S. & Y.
	SWING CHECK	BRONZE 92 Sc. Regrinding 352 Sc. Disc Type 762 Sc. Regrinding IRON 623 Sc. Regrinding 624 Fl. Regrinding 294 Sc. Disc Type 295 Fl. Disc Type	BRONZE 762 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type	BRONZE 962 Sc. Regrinding 260 Sc. Disc Type IRON 338 Sc. Disc Type 339 Fl. Disc Type
	HORIZONTAL LIFT CHECK	BRONZE 117A Sc. Disc Type IRON 151 Sc. Disc Type 153 Fl. Disc Type 617 Sc. Regrinding 618 Fl. Regrinding	BRONZE 756 Sc. Regrinding 807 Sc. Disc Type IRON 265 Sc. Disc Type 266 Fl. Disc Type 934 Sc. Regrinding 935 Fl. Regrinding	BRONZE 263 Sc. Disc Type 986 Sc. Regr. Renew IRON 265 Sc. Disc Type 266 Fl. Disc Type 934 Sc. Regrinding 935 Fl. Regrinding
B	WATER LINES GLOBE	BRONZE & IRON Same as "A" above	BRONZE & IRON Same as "A" above	BRONZE & IRON Same as "A" above
	GATE	BRONZE 47 Sc. Travel Spindle 49 Sc. Travel Spindle 370 Sc. Non-Rising 368 Sc. O.S. & Y. 670 Sc. Non-Rising 672 Sc. O.S. & Y. 674A Sc. Non-Rising 675A Fl. Non-Rising 676A Sc. O.S. & Y. 677A Fl. O.S. & Y. IRON 325 Sc. Non-Rising 326 Fl. Non-Rising 650 Sc. O.S. & Y. 651 Fl. O.S. & Y.	BRONZE 270 Sc. Non-Rising 275 Sc. O.S. & Y. IRON 251 Sc. Non-Rising 255 Fl. Non-Rising 277 Sc. O.S. & Y. 253 Fl. O.S. & Y.	BRONZE 280 Sc. Non-Rising 282 Sc. O.S. & Y. IRON 203A Sc. Non-Rising 203 Fl. Non-Rising 204A Sc. O.S. & Y. 204 Fl. O.S. & Y.
	SWING CHECK	BRONZE & IRON Same as "A" above	BRONZE & IRON Same as "A" above	BRONZE & IRON Same as "A" above
C	AIR LINES GLOBE	BRONZE 106A Sc. Disc Type	BRONZE 750 Sc. Regrinding 950 Sc. Regr.-Renew	BRONZE 801 Sc. Disc Type 1140 Sc. Regrinding 1150 Sc. Regr.-Renew 970 Sc. Regr.-Renew 976 Sc. **Regr.-Renew** 988 Sc. **Regr.-Renew**
	SWING CHECK	BRONZE 92 Sc. Regrinding 352 Sc. Disc Type 762 Sc. Regrinding	BRONZE 762 Sc. Regrinding	BRONZE 962 Sc. Regrinding 260 Sc. Disc Type
	QUICK OPENING	BRONZE 121 Sc. Disc Type 713 Sc. Disc Type 941 Sc. Disc Type 376 Sc. Sliding Spindle IRON 334 Sc. Sliding Spindle		

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NEXT MONTH—REFRIGERATION SYSTEMS

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Number 109

Paint-Selector Guide

Synthetic vehicles combine with new pigments to produce paints superior to old standby varieties, especially where severe service involves exposure to high humidity, corrosive vapors or high temperature. A few suggestions, presented here in briefest possible form, bring you up to date. Basic information furnished by Sherwin-Williams Co

EXTERIOR SURFACES

Metal watertanks, fences, structural steel, doors, fire escapes, sash
Prime with rust-inhibitive synthetic lead-chromate primer brushed or sprayed. Dries in 1 hr; recoat in 5 hr. Finish with synthetic high-gloss moisture- and weather-resistant paint which dries in 4 hr, recoats in 24.

Metal tanks and piping
Prime as above; finish with bright aluminum exterior paint of the separate paste-and-vehicle type. Dries in 6 hr.

Ornamental iron, hydrants, etc (in color)
Prime as above; finish with full-gloss synthetic enamel covering solidly in one coat. Dries in 6 hr.

Smokestacks, flues, boilers, breechings
Without primer, apply one or two coats of heat-resisting black paint if temperature is 300-500 F. Over 500 F, apply high-heat-resisting gray finish directly to clean bare metal without primer. Bring metal to operating temperature within 48 hr to effect curing of paint.

Galvanized-iron roofs, ventilators
Wash new galvanized-iron surfaces with chemical cleaner before priming. Prime galvanized or lead-coated surfaces with zinc-dust primer. Dries in 4 hr; recoat after 24 hr. Finish as soon after priming as possible with synthetic rust-inhibitive high-gloss paint.

Woodwork
Use undercoater to prime and seal new or weathered surfaces. Allow 5 days drying. Finish with high-quality prepared oil paint.

Masonry, concrete, brick
Use semi-gloss oil paint specified for concrete, cement, brick and stucco. For new, porous surfaces, add prepared mixing sealer.

Roofs, flashings, sheet metal, composition
Use black liquid roof-coating or liquid cement containing asbestos fibre applied with roofing brush.

Pavement markings
Marking paint, brushed or sprayed, covers solidly, dries in 15 min.

Signs, color code for piping, safety striping
Use synthetic full-gloss "bulletin" colors. Dries to touch in 4 hr.

INTERIOR SURFACES

Walls, ceilings
Use undercoat for repaint work, or new wood. Prime plaster, concrete or brick with interior primer and sealer. Dries in 5 hr; recoat after 24-36 hr. Finish with high-light-reflecting oil-type paint, gloss or flat. Steel, same as exterior.

Interiors, high-humidity
Use undercoater. Finish with synthetic gloss paint that produces hard moisture-resistant surface.

Laboratory walls, ceilings
Use undercoater. Finish in full-gloss, semi-gloss or flat with specially formulated fume-resisting paint that resists discoloring action of sulphur, chlorine, ammonia. Dries in 3 hr; recoat overnight.

Dadoes, trim
Rapid-drying synthetic enamel covering solidly in one coat to tile-like full-gloss finish.

Floors
For cement or wood, use rapid-drying full-gloss floor enamel. Dries overnight.

Natural-finish floors
For hardwood floors, use a penetrating varnish that reinforces the fibres of the wood but does not produce a slippery film.

Elevator cars, piping, partitions, lockers, benches, radiators, fire apparatus, stairs, guard railings, miscellaneous metal parts, machinery and equipment
Prime with oil-type lead-chromate rust-inhibitive primer for iron and steel. Dries in 4 hr; recoat after 12-18 hr. Finish with full-gloss synthetic enamel covering solidly in one coat. Dries in 4 hr.

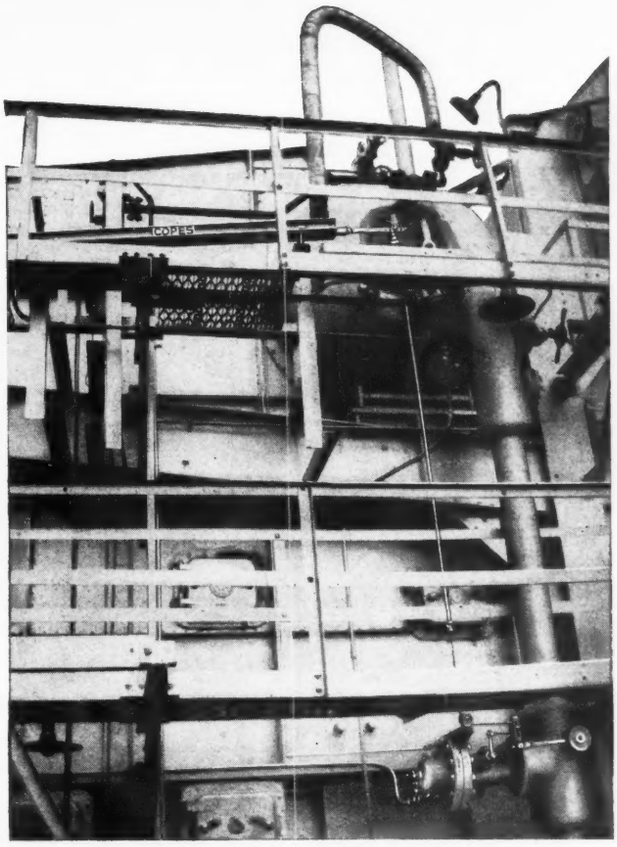
Office ceilings and walls
Prime and seal interior plaster, brick, concrete and porous-type wall-board surfaces with combination pigmented primer and sealer. Dries overnight. Finish with high-light-reflecting oil-type paint drying to dull matte texture best for indirect lighting. Dries in 4 hr; recoat after 36 hr. Alternate is decorative washable oil paint, flat finish.

Office trim
Use quick-drying high-gloss enamel or water-resisting varnish. Dries in 4 hr.

© POWER

At Fort Bend Utilities Company

This all-outdoor Riley Steam Generator carries a combined utility and sugar plant load. The steam demand fluctuates rapidly and over a wide range. The COPES Flowmatic Regulator, shown in the photograph, was installed and adjusted without need of factory service. There is an extreme water level variation of plus or minus one inch.



For Pressures from 80 to 1900 Pounds

In less than four years, over 300 COPES Flowmatic Regulators have been ordered for important utility and industrial plants. They are to operate at pressures from 80 to 1900 pounds gage—on boilers with steaming capacities from 15,000 to 650,000 pounds per hour. This is the widest, quickest acceptance ever gained by any steam-flow type feed water regulator.

FLOWMATIC helps get new boilers on the line..*quickly!*

ONE thing users like about the COPES Flowmatic is the way it swings into almost-perfect operation from the moment it is adjusted and cut into service. They say this simplified two-element steam-flow type feed water regulator is just about as easy to adjust and operate as a simple level control. They tell how the dependably accurate level control saves them time in getting new steam generating units on the line—because all their efforts can be devoted to coordinating other auxiliaries and controls for efficient plant operation.

Want to know how this new COPES operates—where it is used—what results others are getting in regular service? Then write for Bulletin 429—16 pages of informative illustrations and text.

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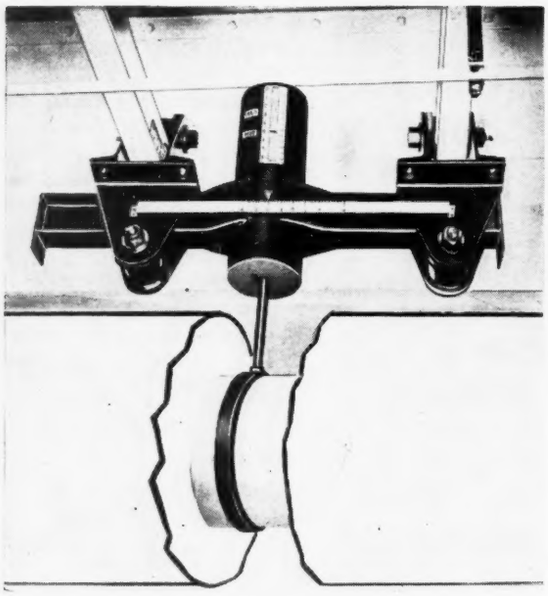
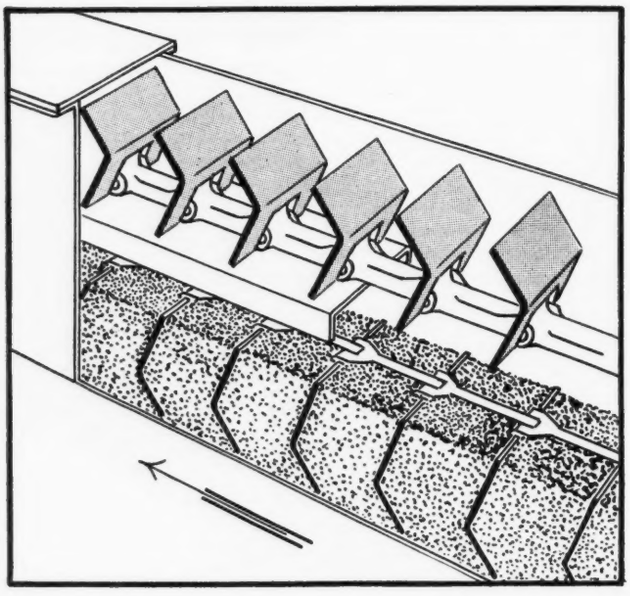
Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters

★ GET CLOSER LEVEL CONTROL WITH THE COPES FLOWMATIC ★ REGULATOR

FEEDS BOILER ACCORDING TO STEAM FLOW•AUTOMATICALLY

WHAT'S NEW IN PLANT EQUIPMENT



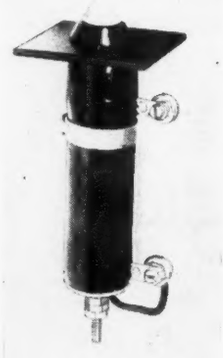


Pipe Hangers and Vibration Eliminators

FUNCTIONAL SPRING HANGERS and vibration eliminators, for high-pressure, high-temperature service, meet Code requirements for pressure piping. Spring assemblies are uniform length and elevation; hangers are easily installed and automatically adjusted to any location. Three types of vibration eliminators, all with double-acting spring effect, permit swivel action in all directions. By adjusting location of spring seats, eliminators operate at all times with minimum spring action. Functional spring hangers, Pivotal Rod Types 1, 2 and 3, are used where lateral movement is limited to the extent that carriage hangers are unnecessary. Pivotal connection within hanger permits two ends of hanger to pivot between extreme positions at considerable angles to each other. Load indicators on outside of spring casing provide a measure of load on hanger in relation to initial dead and live loads when system was installed. Carriage hangers, Types 4, 5, 6 and 7, permit large line movements in all directions. Multiple rolling action accommodates thermal movements of piping and permits hangers and rods to remain vertical. Graduated scales attached to horizontal rollers, as well as to spring element, give check readings on pipe expansion, loss of cold spring, and show existing load conditions through any operating range. *Power Piping Div, Blaw-Knox Co, Pittsburgh, Pa.*

Indicating Lamps

IMPROVED LINE OF LAMPS for visual or pilot light indication on switchboards, switchgear, panels and controls. Feature is special material in color cap which allows less lamp



voltage with equal brilliance and corresponding longer lamp life. Receptacle is made of insulating material and mounts from panel-front through $\frac{3}{4}$-in. hole. Resistor slips over receptacle, taking little space and allowing stronger resistor construction. Bulb may be removed or replaced without use of tongs, wrenches, pullers, or other tools. *Allis-Chalmers Mfg Co, Milwaukee, Wis.*

Sensitized Metal

BECAUSE OF DEFENSE DEMANDS AND OPM RULINGS, company which formerly produced sensitized aluminum sheets now announces new process, whereby other materials, such as steel plate, brass, copper, plywood and plastics, can be sensitized. Some materials can be secured in any commercial thickness and can be used for making templates. In such case drawing is photographed directly on sensitized surface then developed. This is said to save time, eliminating necessity of machinist or tool maker sketching template drawing by hand. *Republic Engineering Products, Inc, 480 Lexington Ave., New York, N. Y.*

Bulk Conveying System

BULK-FLO IS POWER-OPERATED CONVEYOR for positive and continuous conveying of flowable granular, crushed, ground or pulverized materials of a non-corrosive non-abrasive nature in capacities from 1 to 140 tons per hr. Conveying medium employs specially designed chain, to which solid peak-top flights are attached at every pitch. These divide material in conveyor duct into continuous series of batches, which are moved positively by peak-top flights, whether the load is full or only partial. Elevating conveying units may follow almost any desired path—horizontal, inclined, vertical or curvilinear, and a single self-contained unit may carry in all these directions in same vertical plane. *Link-Belt Company, 307 N Michigan Ave, Chicago, Ill.*

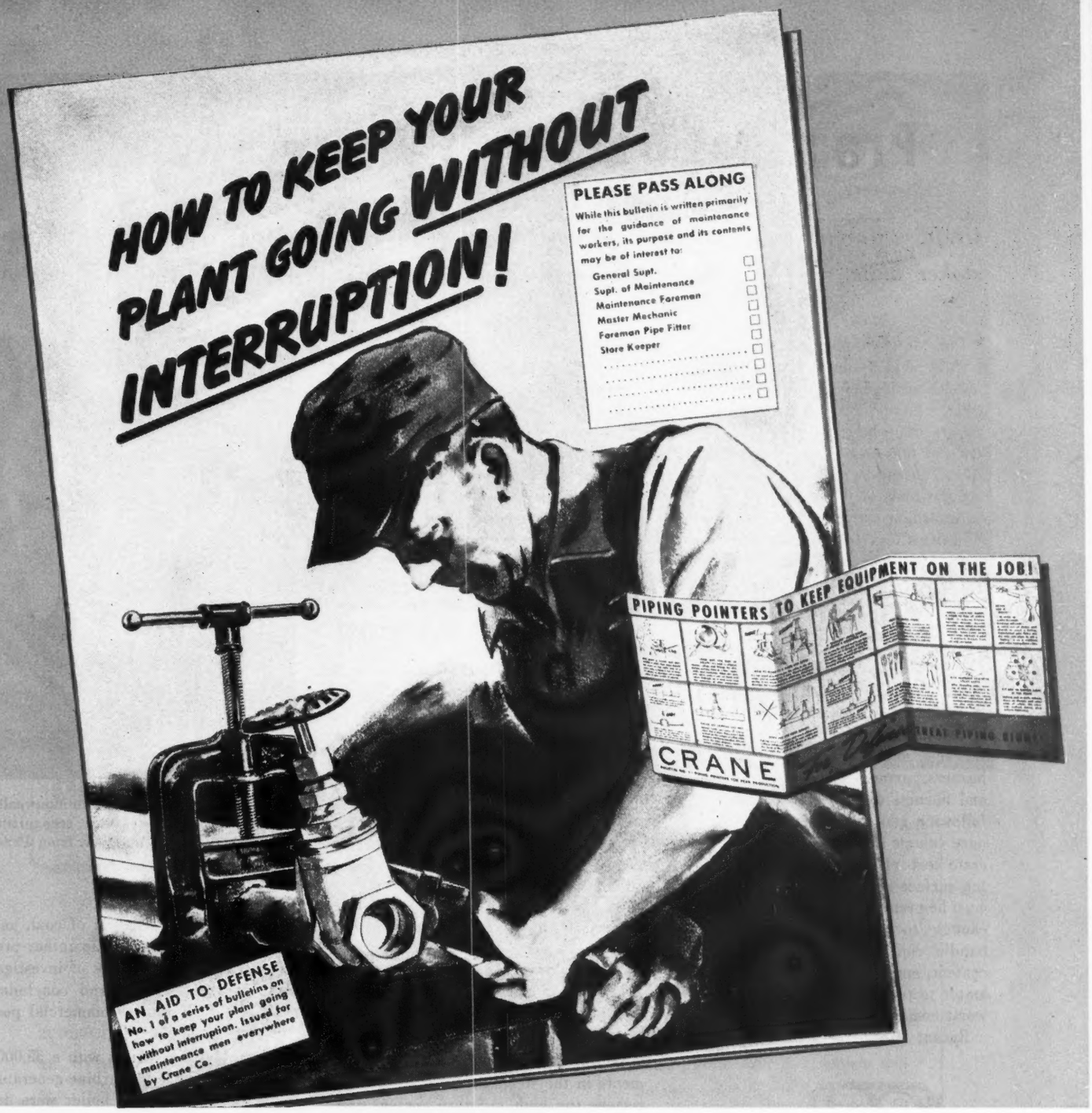
Bearings

IMPROVED LINE OF SOLID and split-journal bearings labeled and packed for shipment. Individual bearings have machined bases and faced ends, and are gunmetal-finished. Both styles tapped for grease cups or pressure fittings, while ample storage-groove in top provides proper lubricant distribution. *Jeffrey Mfg Co, Columbus, Ohio.*

Lubrication System

ALEMITE PROGRESSIVE LUBRICATING SYSTEM delivers predetermined quantity of lubricant to a range of three to 20 bearings, and when job is completed, signals operator. Has four major improvements designed expressly for large-scale lubrication: (1) All bearings in one piece of equipment can be lubricated

(*Continued on page* 146)


HOW TO KEEP YOUR PLANT GOING WITHOUT INTERRUPTION!
PLEASE PASS ALONG
While this bulletin is written primarily for the guidance of maintenance workers, its purpose and its contents may be of interest to:
General Supt.
Supt. of Maintenance
Maintenance Foreman
Master Mechanic
Foreman Pipe Fitter
Store Keeper
PIPING POINTERS TO KEEP EQUIPMENT ON THE JOB!
CRANE
AN AID TO DEFENSE
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Crane announces publication of a new series of Shop Bulletins designed to help you train new maintenance men and improve the work of veterans. Bulletin No. 1 is now ready. It covers workmanship—shows a lot of practical hints on how to install and service piping equipment. Ask your Crane Representative—or write us—for copies to be distributed among your maintenance force.

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Practical Data on Power Problems

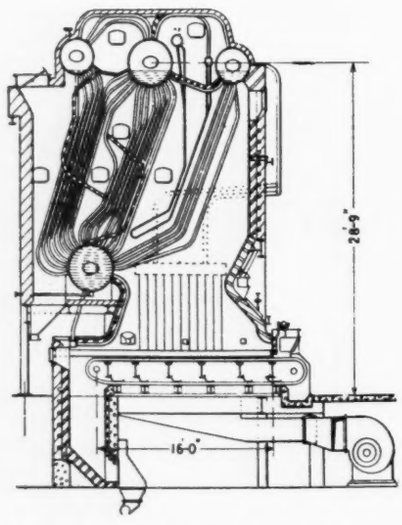
Useful information on boilers, air heaters, turbines, cooling towers, pulverized-firing and stoker units, coal- and ash-handling equipment presented at ASME Semi-Annual Meeting

▶THE SEMI-ANNUAL MEETING of the ASME, held June 16–19 at the Hotel Muehlebach, Kansas City, Mo., provided a bumper crop of practical power papers. The large attendance of western and mid-western engineers brought special attention to handling and burning the fuels of this area.

According to A C Foster, Foster Wheeler Corp, the successful pulverizing and burning of low-grade midwest coals requires design provisions for: (1) low ash-softening and fusion temperatures, (2) negligible coking tendencies, (3) generally high moisture content, and (5) low to moderate grindability.

Discussion of specific factors involved in furnace proportions, arrangement of furnace cooling surface, location of burners, arrangement of superheater, and fineness of pulverization led to the following general conclusions: (1) furnace volume should be large, with moderate heat-release rates, (2) ample cooling surface should be provided, (3) air must be preheated to a temperature high enough to enable the pulverizer to handle coal with maximum moisture content, and (4) mill capacity must be ample to provide fine grinding with the worst coals likely to be encountered.

Recent installation of chain-grate stokers show advantage in a radically different furnace design from that usually employed, according to F X Gilg, Babcock & Wilcox Co. This furnace features relatively short front and rear arches, giving an "open furnace" in place of the usual narrow throat, long rear arch. High-velocity overfire air provides necessary turbulence and helps maintain ignition. Results cited in this paper, for close to a dozen furnaces of this type, show relatively high burning rates maintained without excessive slagging or grate maintenance and with high efficiency.



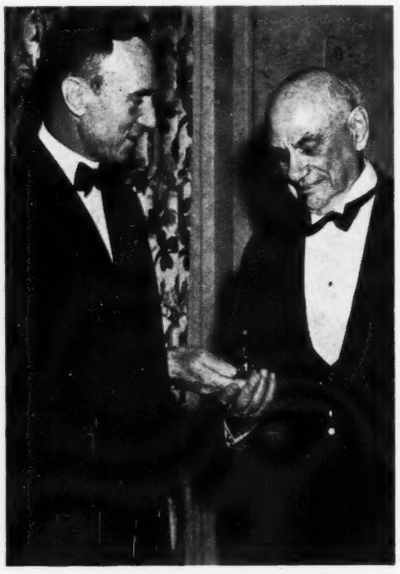
Advantages are claimed for this "open-furnace" design for chain-grate units; high-pressure overfire air is necessary

Experience indicates that the long-rear-arch design must be retained for such fuels as lignite, anthracite, coke breeze, or other low-ash fuels. In answer to questions Mr. Gilg explained that the overfire air represents only about 10% of the total air at maximum rating; the important factor is velocity to create turbulence. He cited use of pressures of 8 to 9 in. of water and velocities of 10,000–12,000 fpm.

Steam-Drying Lignite

Pointing out that the sub-bituminous coals and lignites of the eastern slope of the Rocky Mountains and the Northern Great Plains area represent two-fifths of the reserves of the U. S., V F Parry, U. S. Bureau of Mines, described experiments in the steam-drying of lignite to remove the high moisture content and thus make shipping economical over relatively long distances. In addition to showing the results attainable by steam drying, Mr Parry presented estimates on the cost of a commercial plant for the process and a chart comparing delivered costs of bituminous coal and raw and dried lignite in the Northwest. These estimates indicated the possible extension of lignite markets.

Further research in development of new fuels was described in a paper "Colloidal Fuel" by J E Hedrick, Kansas State College. By mixing powdered coal with oil it was hoped to get a fuel that would retain the desirable features of oil but would be cheaper. Present research is directed at study of the characteristics of such a fuel, with particular regard to stability, flow through pipes, atomizing, grinding of coal, and mixing of coal and oil. The author presented preliminary results of investigations on these factors and concluded that colloidal fuel has commercial possibilities.

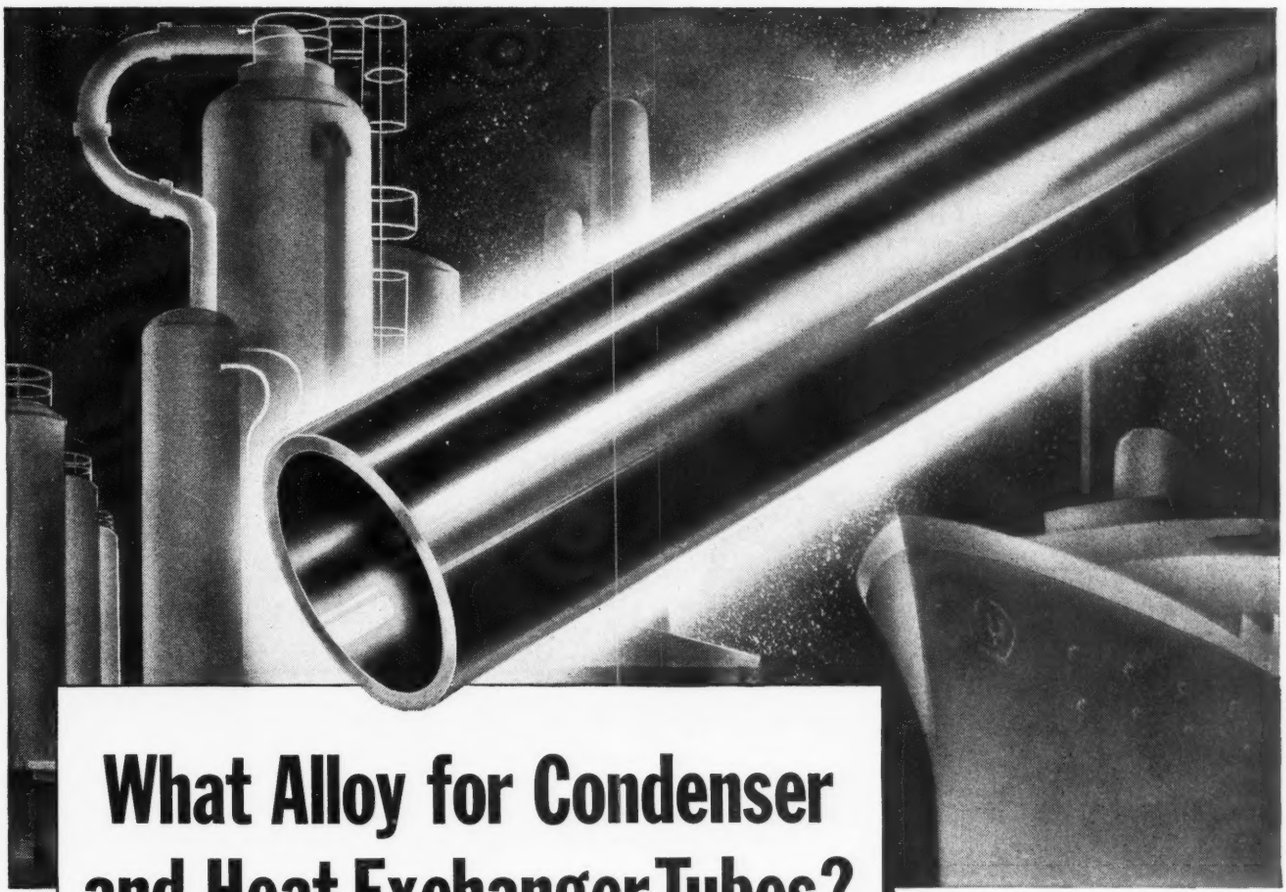


W L Abbott, formerly of Commonwealth Edison Co, receives badge recognizing 50 years of service to ASME from President W A Hanley

Operating experiences with a 35,000-kw, 1290-lb, 925-F turbine-generator and a 420,000-lb-per-hr boiler were described by J F McLaughlin, Iowa Power & Light Co. Turbine availability was 79.8% for 1939 and 95.5% for 1940; early outages resulted from excessive axial thrust and from failure of impulse blading. Modification of high-pressure reaction blading, installation of a new type of thrust bearing and replacement of impulse blading to bring the design into accord with latest developments in partial admission blading, cured these troubles. No operating difficulties were experienced with either condenser or auxiliaries.

Boiler availability was 78.5% in 1939 and 92.0% in 1940. Plugging at the cold end of the air heater was eliminated by installing air recirculators and a cold-air bypass to keep exit-gas tem-

(*Continued on page* 132)



What Alloy for Condenser and Heat Exchanger Tubes?

To obtain maximum service life for condenser tubes there are many operating factors to be considered—character of the cooling water, turbulent flow, and entrained air, to name but a few. Naturally your tube alloy should be selected in accordance with the combination of these factors existent in your plant.

Through their unparalleled experience in the field, Anaconda engineers have accumulated a vast fund of knowledge with which to meet these problems. Their service is available upon request. They can cooperate in analyzing your requirements and place before you performance records of copper alloys under similar operating conditions. No charge is made for such consultation. 41113

The American Brass Company manufactures a wide range of tube alloys for condenser and heat exchanger installations. They are fully described in our latest Condenser Tube Publication B-2, which will be sent upon request.

ANACONDA

Anaconda Copper & Brass

THE AMERICAN BRASS COMPANY, General Offices: WATERBURY, CONNECTICUT

Subsidiary of Anaconda Copper Mining Company • In Canada: Anaconda American Brass Ltd., New Toronto, Ontario

perature above 230 F. Upper furnace sidewalls were originally built of bare tubes on 10¼ and 15⅜ in. centers with exposed firebrick between. Slag adhering to the firebrick built up to considerable thicknesses until chunks would fall, dropping on the furnace screen tubes and causing leaks in the rolled joints. Replacement with closely spaced finned tubes, changes in burner angles, and installation of air baffles to deflect secondary air into the coal stream materially reduced the slag adhering to the walls.

Because air-heater surface, operating at low temperature, makes it possible to attain high boiler efficiency, and because air-heater surface is relatively low in cost, economics point to using the largest air heater possible within the limits set by minimum gas temperature to avoid corrosion and maximum air temperature usable on the firing equipment. "Air-Heater Facts: 1926–1941," by E L Hopping and D F Schick, Philadelphia Electric Co, discussed the corrosion problem in some detail, stressing the fact that metal temperature has a more direct bearing on formation of sulphuric acid due to condensation than either gas or air temperature. The authors cited experience with recircula-

(*Continued on page* 136)

Two methods of avoiding air-heater corrosion resulting from excessively low gas temperature

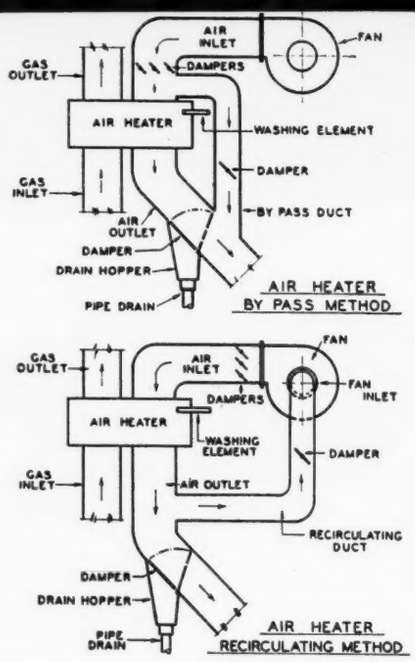


TABLE I—COAL-HANDLING COSTS FOR 14 CENTRAL STATIONS

Coal delivered by water, rail, truck	*Year installed*	*Capacity to bunker, tons per hour*	*Cost of installation, including docks, tracks, pits, cranes, conveyors, etc., thousands*	*Tons coal burned, per year*	*Load factor on coal-handling equipment*	*Maintenance costs, cents per ton*	*Operating labor, cents per ton*	*Fixed charges, based on 12% per annum, cents per ton*	*Total fixed and operating costs, cents per ton*	*Description of System*
W	1939	400	$691	124,000	3.5	1.3	5.0	67.0	73.3	Coal delivered on dock by self-unloading lake boats, gantry crane to storage, or to belt conveyors to plant.
W	1925	350	1220	382,046	12.5	5.3	7.6	38.1	51.0	Gantry crane from lake boats to storage, or by car and belt conveyor to plant. Auxiliary dragline storage.
W	1926	250	655	547,574	25.0	4.2	4.0	14.4	22.6	Clamshell from river barges to belt conveyors to plant or to Lidgerwood storage.
W	1928	125	978	175,879	16.1	4.8	6.6	66.8	78.2	Clamshell from ocean steamers or barges to belt conveyors, to plant, or to dragline storage.
R	1939	200	360	196,000	11.2	0.7	6.1	22.0	28.8	Cars discharge by gravity into pit, to belt conveyors, to plant or to dragline storage.
R-T	1939	125	160	122,924	11.2	4.5	6.4	15.8	26.7	From cars by gravity to pit, to belt and bucket elevator, to dragline storage or to plant by belt.
R	1936	100	212	79,360	9.1	1.9	7.5	32.0	41.4	From cars by gravity to pit, to belt and bucket elevator, to dragline storage or to plant by belt.
R	1913	75	66	109,000	16.7	2.4	5.3	7.3	15.0	Stationary tower with clamshell bucket from cars to distributing belt, then locomotive crane for storage.
R	1925	75	112	217,588	33.0	2.1	4.4	6.3	12.8	Locomotive crane lift-bucket unloads cars to pit, to chain- and bucket-elevator, scraper conveyor, locomotive crane for storage.
R	1927	60	160	62,606	11.9	6.1	9.8	30.7	46.6	Cars discharge by gravity into pit, to belt and bucket elevator, to scraper conveyor. Loco crane for storage.
R	1928	60	164	43,860	8.3	4.9	10.1	45.6	60.6	Cars discharge by gravity into pit, to belt and bucket elevator, to scraper conveyor. Bridge crane for storage.
R	1926	50	97	54,636	12.4	4.8	8.1	21.5	34.4	Cars discharge by gravity to belt and bucket elevator to scraper conveyor. Bridge crane for storage.
R	1920	40	20	40,077	11.4	3.4	6.7	6.0	16.1	Cars discharge by gravity to shallow pit, to inclined scraper conveyor, to bunkers. Storage by portable conveyor.
R	1937	150	185	275,376	21.0	....	....	8.1	18.7	Cars dump into pit, to skip hoists, to belt distributors. Storage by locomotive crane and bulldozer.
				Average	14.6	3.6	6.7	27.2	37.6	

LOOK!

A REAL TIME SAVER FOR LOAD AND VOLTAGE SURVEYS

An Instrument That Gives You a Month's Operation on a 30-inch Chart

Type CF-1 low-chart-speed recorder
(both ammeters and voltmeters are available)

WHEN analyzing load or voltage surveys, it is no longer necessary to reel off 60 ft of strip chart, or to examine a number of round charts. This new instrument gives you a 30-day operating record on a 30-in. chart—thus you can quickly check current or voltage conditions for an entire month, or for any 24-hr period.

A 4-day record can be seen through the glass window. This makes it possible to check the record without opening the instrument and unrolling the chart.

IT'S INKLESS—REQUIRES NO ATTENTION

This new instrument is an addition to our proved Type CF line of inkless recorders. It is the inkless feature that makes possible the one-inch-per-day chart speed. At such a low speed, an ink recorder would form pools of ink that would blot out the record.

The inkless feature also enables the instrument to operate for a month without any attention, because the old troubles of pen clogging and ink freezing or evaporating are eliminated. Accurate in extremes of temperature—from −10 F to 120 F.

This instrument will be a worth-while addition to your testing equipment and should soon pay for itself in the time it saves. Bulletin GEA-3187 gives complete information. General Electric Company, Schenectady, N. Y.

HEADQUARTERS for ELECTRICAL MEASUREMENT

GENERAL ELECTRIC

Over-Experience . . .

A FEW WEEKS BACK, we were heading over one of those new super-highways—you know, concrete pavement and stone shoulders, with a deep ditch on each side. All of a sudden a cat passed us, skidded to read a sign, then streaked lickety-split up the road. When we got there, I slowed to read the sign too. It said: DIRT ROAD 4 MILES AHEAD.

That was a cat who had too much experience. All his life he'd been taught to hunt a patch of dirt when needful—and now, when his comfort was at stake, habit was so strong he couldn't break it.

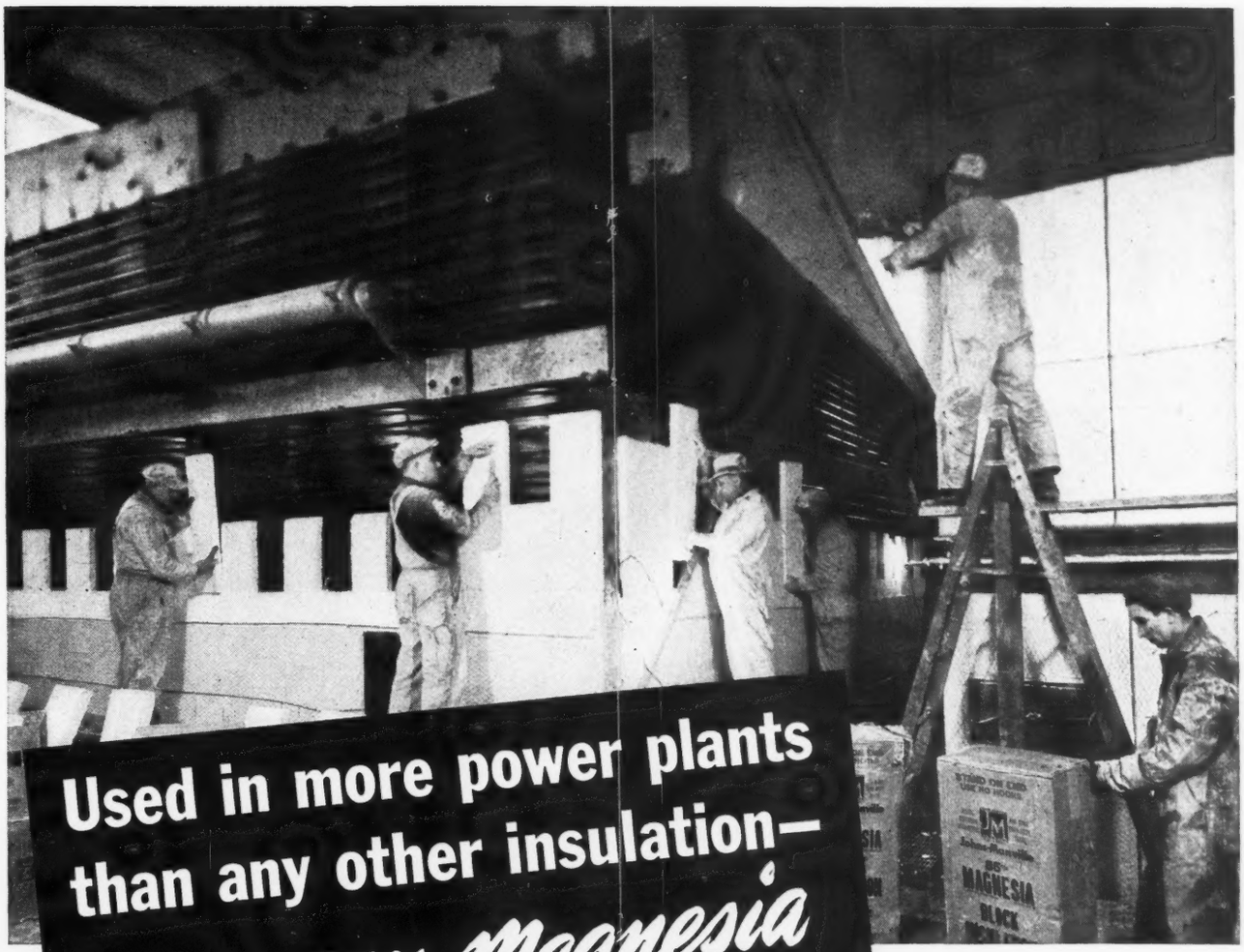
Part of our trouble is our dependence on the parables we learn as children, which, left alone and implicitly believed, soon grow into habits. One of these is "Practice Makes Perfect." A mistake, repeated often enough, becomes a very successfully performed one—*but it is still a mistake.* It may even delude its maker—if he hasn't already deluded himself. Mistakes are assets only if you don't make the same one twice.

It's important to remember that as we get older our tendency is to believe that experience is the best teacher. It is—providing we keep our minds open for the *new* experience when it comes along. Experience told "experts" that Fulton's steamboat would never work, that the Ohio River could never go higher than five feet over its previous high in 1936, that the Maginot Line was impregnable. But the experts were wrong in each case, just as in every significant change affecting our civilization.

The great danger is *over-experience*—the cocksure knowledge that insists all conditions are known, that nothing new can ever be developed to change certain "fundamental" facts. As Mark Twain said once, "We should be careful to get out of an experience only the wisdom that is in it—and stop there; lest we be like the cat that sat down on a hot stove lid. She will never sit down on a hot stove lid again—and that is well; but she will also never sit down on a cold one any more."

So, each time you catch yourself being certain that this idea won't work or that suggestion is impractical, *because of your experience,* be sure that all the factors upon which you base your opinion are the same as they were when *you* sat on the stove lid. Otherwise, like the burned child, you'll be freezing to death because you're afraid of fire.

George Edwards
Engineer



Used in more power plants than any other insulation—

J-M 85% Magnesia

For power-plant service up to 600°, it's a habit with engineers to specify J-M 85% Magnesia Blocks and Pipe Insulation.

It's a good habit, too, they'll tell you, for no other material provides such satisfactory performance on the job. That's because J-M 85% Magnesia delivers the right combination of long life and high insulating value that means *permanently* efficient, economical service.

And it's easy to install, for it is light in weight, readily cut and fitted. For details, write Johns-Manville, 22 East 40th St., New York, N. Y.

A Few Other J-M Insulating Materials

For cold rooms, ducts and refrigerating equipment—
Rock Cork Sheets

For refrigerated piping—
Rock Cork Pipe Insulation

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For hot or cold service-water lines—
Pre-Shrunk Wool Felt Pipe Insulation

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Pre-Shrunk Asbestocel Pipe Insulation

For steam lines to 700° F.—
Asbesto-Sponge Felted Pipe Insulation

For superheated steam lines—
Superex-Magnesia Combination Insulation

For furnace insulation—
Superex Blocks, Insulating Brick (3 types), Insulating Fire Brick (4 types), Sil-O-Cel C-3 Concrete

Other insulations for special requirements

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FOR EVERY TEMPERATURE...EVERY SERVICE CONDITION

IN A HURRY?

Get it Tight the First Time with a DART

There's no try-try-again for tight joints—no costly delays—when you hook-up with Darts. For Darts make up *tight the first time*, quickly, easily. They're made that way: They've got two bronze seats, ground and matched for quick, sure tightness. Extra heavy malleable iron bodies and nuts, to minimize stretch and withstand wrench abuse. And remember this. A Dart is good for more than just one tight joint. You can install it again and again and get tight joints every time. Next time you ask for a union, ask for a Dart.

DART UNIONS

E. M. DART MFG. CO., Providence, R. I.

Sales Agents: The Fairbanks Company, New York, and all branches

Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

Reversed Refrigeration

(*Continued from page* 77)

require a greater investment in equipment than required for summer air-conditioning alone. Exceptions to this general rule are department stores and similar establishments where heavy lighting and human loads serve to measurably increase summer cooling requirements and decrease winter heating loads.

In general, operating experience in the first year of this installation did not differ materially from that encountered in conventional jobs. Some thermostats were relocated, fans were speeded up and convectors were adjusted during the usual "tune-up" period. It was found that the reversed-cycle operation imposed unusual conditions on the expansion valves, which operated at 200 lb head pressure in the winter and at only 90 lb in the summer. However, it was found possible to meet this wide pressure range with gas-charged Sporlan units. Log records show that five condensing units out of the total of eight handled the heating load during the winter of 1940-41 and that electric booster heating was not necessary. During the summer months, 3 units will carry the load under average conditions.

Maintenance on the compressors, condensers, and water-chilling units during the first year was confined to minor adjustments and control settings. A special report form facilitates regular monthly inspection of the condensing units, water chillers, and controls.

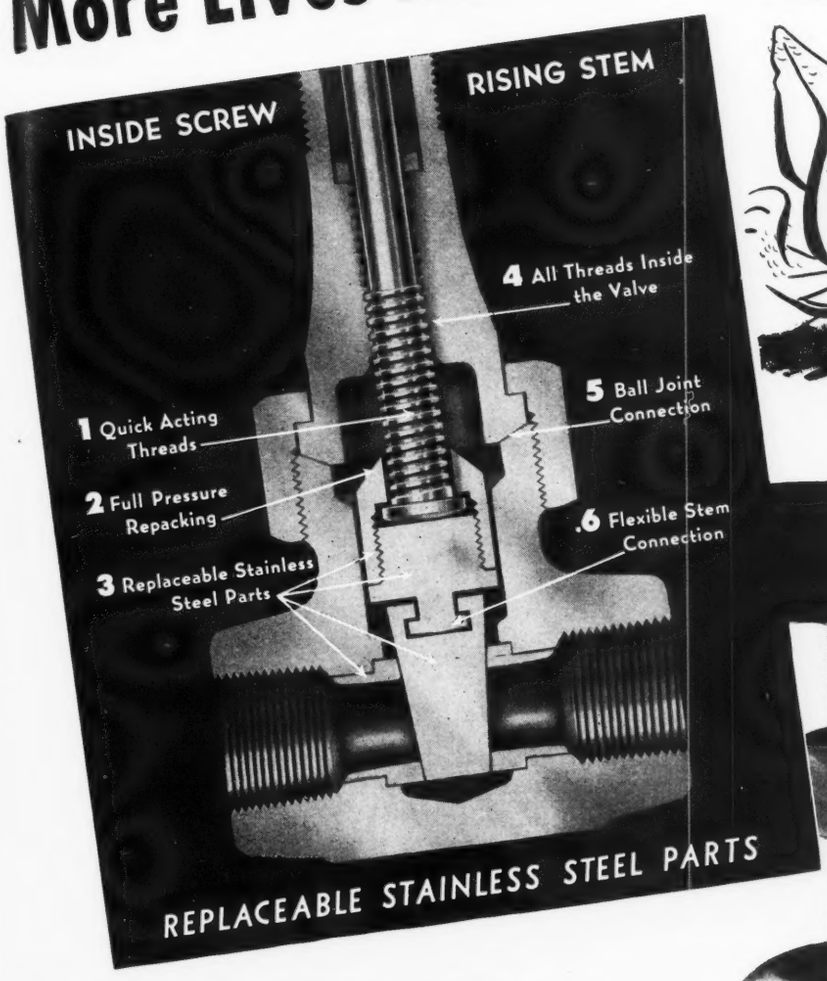
Power Problems

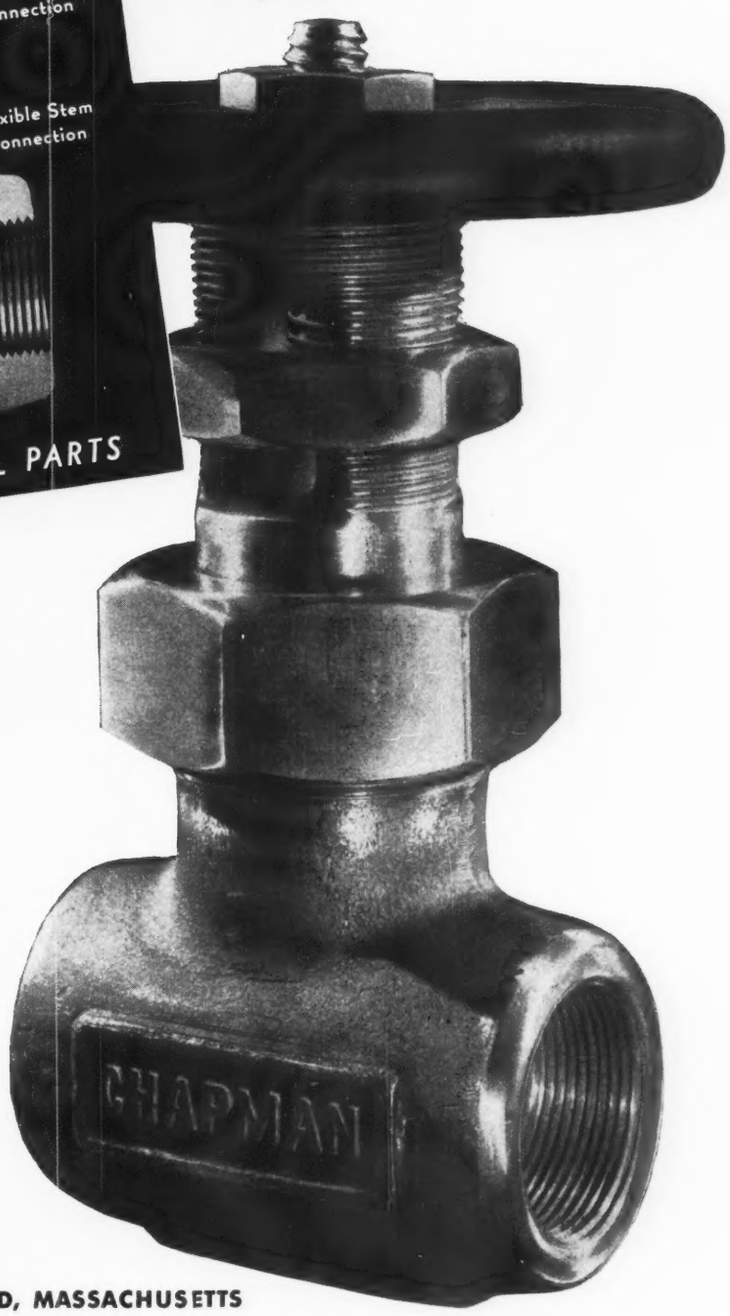
(*Continued from page* 132)

tion and bypass arrangements for limiting gas temperature and with use of special materials in sections of air heaters subject to severe corrosion.

Pointing out that decrease in size of coal used by central stations has increased unloading time and thus reduced coal-handling capacity of many plants and stressing the fact that more common use of the bulldozer to compact coal piles and do short-distance hauling has decreased investment in coal-handling equipment, George C Daniels, Commonwealth & Southern Corp, presented coal-handling costs in 14 plants, see table on page 132. A companion paper, by E U Titus, Allen-Sherman-Hoff Co, covered the considerations involved in designing a dust- and fly-ash-handling system for various types of

More Lives than a Cat





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Forged-Steel Gate Valves

One thing certain about a Chapman List 960 Valve —it always stays young and healthy. Put it on any line from ¼" to 2"—bang 800 lbs. pressure at 750° through it, or 1500 lbs. cold working pressure—it's built for that kind of service. And—if and when the vital parts finally do show signs of wear, simply replace them with Chapman Stainless Steel Parts. Your valve is again as good as new.

Added, of course, are other Chapman "Trouble-Shooting" features—all quick-acting, inside threads, ball joint connections, full pressure repacking, and flexible stem connection. No valve gives you more.

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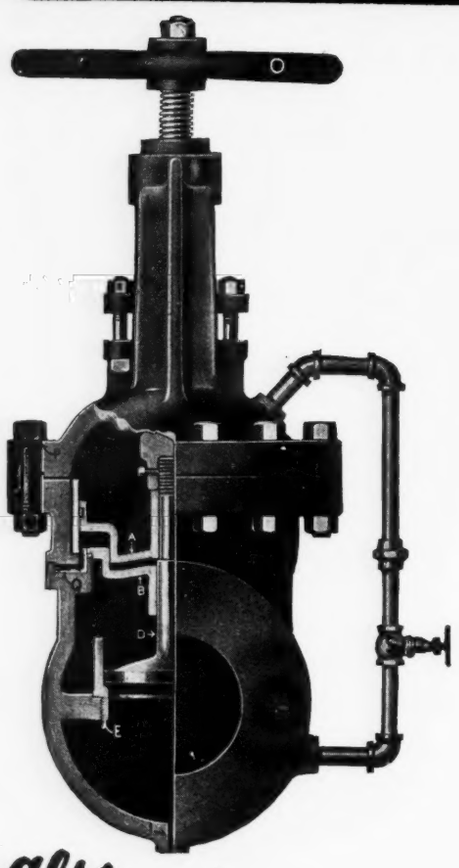
Golden-Anderson

SPECIALTY

VALVES



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● With G-A's throttle and emergency stop valve, you're assured of protection against damage to valuable property, for it automatically shuts down any overspeeding engine or turbine. It works instantly . . . mechanically, electrically, or by hand . . . even to being tripped by a push button from remote points. No unit can exceed safe operation speed when equipped with this valve, as maximum speeds are rigidly controlled. Comes in angle and globe patterns from 2½" to 16" in size. You'll find these quality G-A valves in use, under every pressure, on all types of steam engines and turbines. For a more detailed description of the complete G-A line, write for our free catalog today.

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industrial and utility boiler plants.

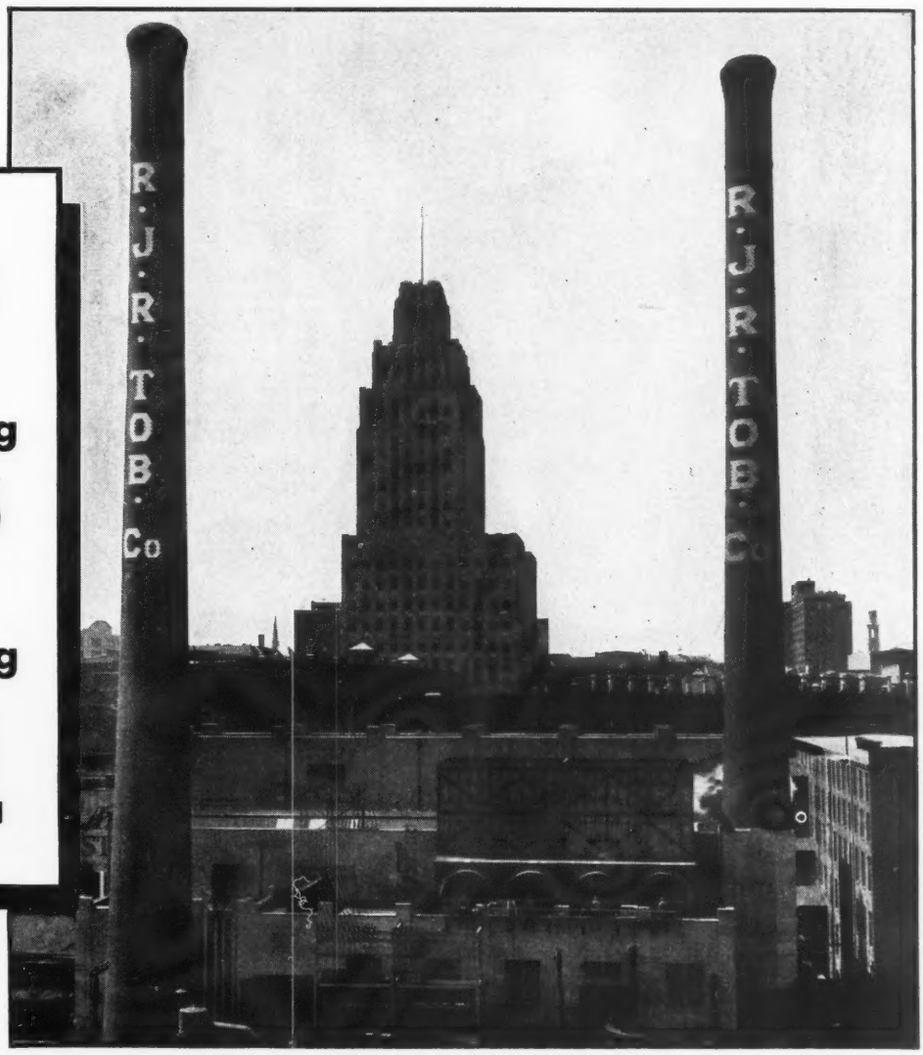
Elimination of uncertainties in the application of fusion welding have vastly widened its field of usefulness in boiler-repair work, according to F C Hutchison, The Linde Air Products Co. Tracing the early history of fusion welding as applied to "safe-ending" of fire tubes, the author told how growth of knowledge of fusion welding and experience with such repairs in states not restricting welding repairs led to eventual liberalization or removal of limitations in most code states. Qualifications of welders proved an entering wedge for the introduction of fusion-welding processes and since 1935 fusion welding has passed through the greatest development in the history of the art. The new Rules for Welded Repairs have now been distributed to the members of the National Board of Boiler and Pressure Vessel Inspectors, and will no doubt be recognized by all inspection jurisdictions. The author concluded with data on use of fusion welding for piping repair and on short-time stress relief.

Mechanical-Draft Towers

After defining the basic types of water-cooling equipment (spray ponds, atmospheric and mechanical-draft cooling towers) and discussing the characteristics, limitations and advantages of spray ponds and atmospheric towers, L T Mart, The Marley Co, devoted the greater part of his paper "Cooling Tower Progress" to mechanical-draft towers. By an interesting combination of text and illustrative diagrams, Mr Mart compared the forced- and induced-draft types and pointed out the services to which each is best adapted. He likewise traced the evolution of im-

This giant electric shovel, one of world's largest, removes 32 cu yd of overburden in a Kansas strip-coal mine, visited by ASME members

POWER
to make slower-burning CAMELS comes from better-burning COAL



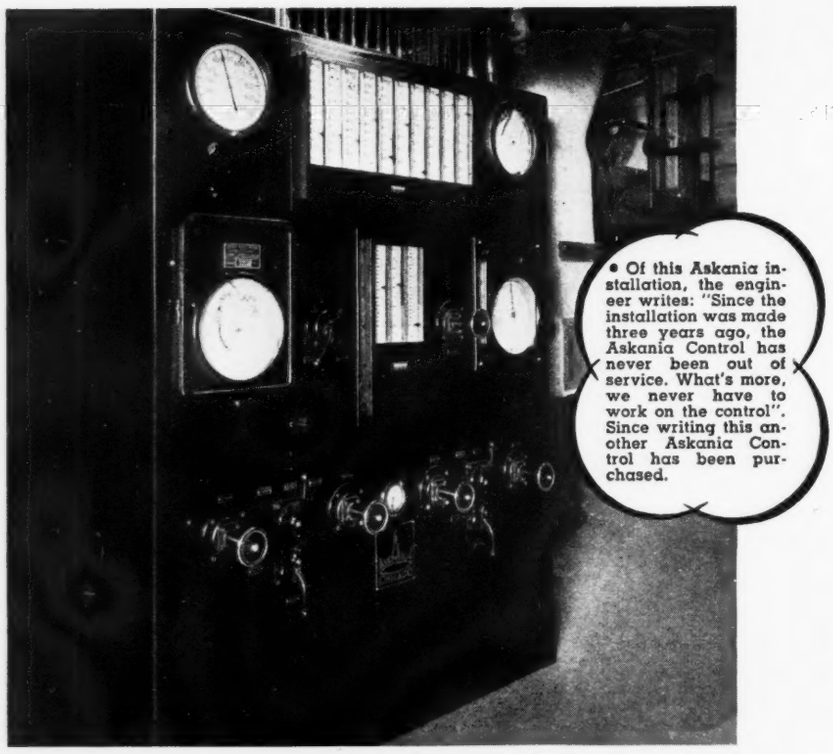
Central power plant and factory, R. J. Reynolds Tobacco Co.

FOR making process steam and electric power, the R. J. Reynolds Tobacco Company, of Winston-Salem, N. C., uses about 50,000 tons of clean, prepared coal per year in the manufacture of Camels and other tobacco products. In their central power plant, modern coal-burning equipment is capable of producing steam at the rate of 320,000 pounds per hour . . . and, through their generators, of turning out 10,000 kilowatts of electric power. "Steady, heavy-duty operation is demanded of our plant," says Chief Engineer, R.P. Reece, "and we know that coal is dependable, efficient and economical in fuel and upkeep costs."

ARE YOU PAYING MORE THAN YOU NEED FOR POWER? If you're not sure of the answer, you'd be wise to call in the Fuel Service Engineers of Chesapeake and Ohio Lines. These trained specialists —working at *no cost* to industrialists—have been responsible for fuel and maintenance savings and for higher operating efficiencies in many a plant. Why not let them survey *your* establishment? They are simply consultants —they examine the layout, consult with plant engineers and make suggestions often leading to appreciable savings. If you'd like them to visit your plant, simply write GEORGE H. REINBRECHT, Coal Traffic Manager, Chesapeake and Ohio Lines, 2901 Terminal Tower, Cleveland, Ohio. Remember, you incur no obligation.

IT PAY$ TO U$E MODERN . . .

Chesapeake and Ohio Lines


• Of this Askania installation, the engineer writes: "Since the installation was made three years ago, the Askania Control has never been out of service. What's more, we never have to work on the control". Since writing this another Askania Control has been purchased.

Can you afford NOT to have Askania Control?

OF course you *want* the best there is in combustion control but . . . there is always that human tendency to balk at initial cost and seek to justify something not so good by saying in effect: "Askania is better than I need".

The answer to this is written into the operating record of every Askania-equipped boiler plant. From smallest to largest, they show that you can't afford NOT to have the precision and trouble-free operation of Askania Regulation.

You can't afford NOT to have the unequalled sensitivity, yet inherently stable control, of the exclusive Jet Pipe Principle. You can't afford not to have this system that gives you a freedom from maintenance that would make it the most economical control even if its higher efficiency were completely disregarded.

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ASKANIA *Combustion* **CONTROL**

provements in fans, motors, casings, structural design, spray-drift eliminators, water distribution, noise reduction, and other details which make today's lighter and cheaper towers such an advance over the older types.

Various angles of turbine design and operation were presented in a group of three papers. J K Salisbury, General Electric Co, described a method for quickly and accurately determining the improvement in heat rate resulting from regenerative feedwater heating with any steam conditions. This method of analysis is based on the fact, proven mathematically in the paper, that with other conditions fixed, the heat rate of a turbine depends only on the fractional quantity of steam extracted, regardless of internal variations in the heater cycle. Charts and tables make it possible to arrive at the heat rate of a proposed cycle in a fraction of the time formerly required.

Turbine Oil Stability

Discussing "Stability Characteristics of Turbine Oils," H R Peterson, Standard Oil Co of Indiana, pointed out that all oxidation products act as emulsifiers and that turbine conditions, such as rate of circulation, presence of metals, and high temperatures, promote oxidation. Accelerated testing methods for turbine oils are being developed to simulate these conditions. Acid treating and solvent extraction have improved stability; inhibitors give good results. Inhibited oils are superior in relation to acidity and if all asphaltenes are removed, neutralization number is a good criteria of stability.

The author also stated that inhibited oils show up well on "steam emulsion number", pointing out that initial demulsibility is not as important as maintenance of demulsibility. Because presence of contaminants and oxidation products has an important effect on emulsibility, adequate reclamation equipment is important regardless of oil type. Operating data was presented for 560 turbines, of which 60% were equipped with reclaiming equipment of some kind. In reference to corrosion, Mr Peterson expressed the opinion that adding old oil may help but this procedure increases oxidation and decreases demulsibility. Rust inhibitors may be added to reduce corrosion.

Indicating the need for an instrument to measure all steam-turbine governor characteristics and also a test method to insure minimum system disturbance during testing, A F Schwendner, Westinghouse Electric & Mfg Co, went on to say that such an instrument must be flexible enough to handle all kinds of

Why you get more with TUBE-TURN Welding Elbows!

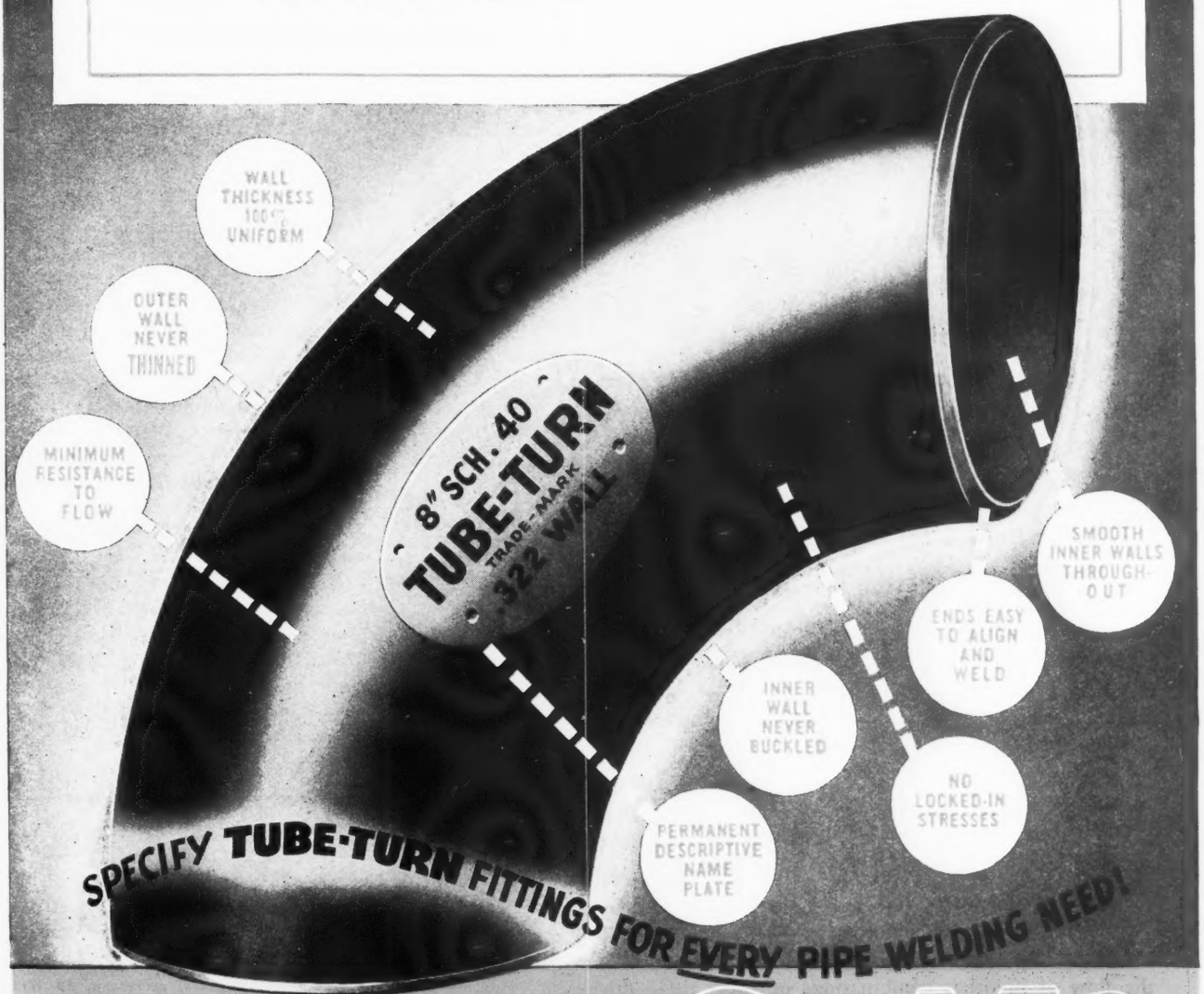
Shown below are vital engineering advantages that tell quickly *why you get more* with TUBE-TURN welding elbows.

These features are *basic* and *indispensable*—but they are not the *whole* story. Remember also that Tube-Turns, Inc., not only *originated* these "musts" in welding elbows, but *pioneered* the entire welding fitting idea and these many improvements found in Tube-Turn fittings today.

Let these factors guide you in specifying welding elbows—for greater safety, better aligning and welding, permanently trouble-free joints, and stronger, lighter piping systems that save space.

Tube-Turn fittings are available in all types, sizes and weights. Write today for Tube-Turns helpful data book and catalog!

The elbow that made ALL Tube-Turn Welding Fittings famous!



SPECIFY TUBE-TURN FITTINGS FOR EVERY PIPE WELDING NEED!

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governors in the plant. He discussed the governor characteristics to be measured, including stability, regulation, and incremental regulation. To avoid mechanical difficulties and to permit easy change over several ranges of operation, it is necessary to use an electrical instrument. Mr Schwendner described such an instrument and its method of use, pointing out that a complete governor test can be made in four hours, if properly planned. The author also presented results of tests made on several operating governors, using this new instrument.

Inspection Trips

Members attending the meeting made inspection trips to the plants of the Sheffield Steel Corp, the Phillips Petroleum Co, to Northeast Station of Kansas City Power and Light Co, and to the strip coal mine of the Sinclair Coal Co. At the banquet a 50-year badge was presented to W L Abbott, Past President of ASME and formerly Chief Engineer of Commonwealth Edison Co; Dr William McClellan, President of the Union Electric Co, spoke on "Professional Engineering in a Democracy". The following nominations for officers were announced by C E Davies, Secretary of ASME:

President—James W Parker, Vice-President in Charge of Engineering, Detroit Edison Co. *Vice-presidents*—Clarke F Freeman, Vice-President, Manufacturers Mutual Fire Insurance Co; Clair B Peck, Managing Editor, *Railway Mechanical Engineering;* William H Winterrowd, Vice-President, Baldwin Locomotive Works; Willis R Woolrich, Dean of Engineering, University of Texas.

Managers—William G Christy, Smoke Abatement Engineer, Hudson County, N. J.; Herbert L Eggleston, Manager Gas & Refining Depts, Gilmore Oil Co; Thomas S McEwan, Resident Manager-Engineer, McClure, Hadden & Orthan.

MEETINGS

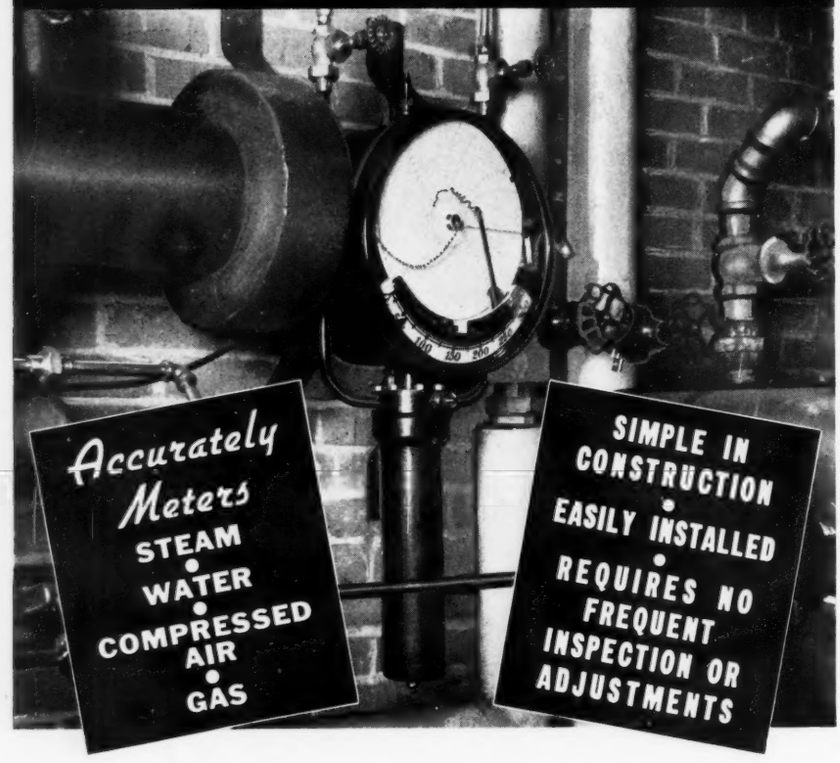
American Society of Mechanical Engineers—*Fall Meeting, Louisville, Ky., October 12–15, 1941. Joint meeting ASME Fuels and AIME Coal Divisions, Lafayette College, Easton, Pa., October 30–31, 1941. C E Davies, secretary, 29 West 39th St, New York, N. Y.*

American Institute of Electrical Engineers—*Pacific Coast Convention, Grand Canyon Hotel, Yellowstone National Park, Wyoming, August 27–29, 1941. H H Henline, secretary, 39 West 39th St, New York, N. Y.*

Technical Association of the Pulp and Paper Industry—*Fall meeting, Ann Arbor, Mich., September 16–19, 1941. P G MacDonald, secretary, 122 East 42nd St, New York, N. Y.*

THE ADSCO FLOW METER

ORIFICE TYPE



EXCEPTIONALLY ACCURATE AT ALL RATES OF FLOW—HIGHLY SENSITIVE TO FLUCTUATIONS IN FLOW

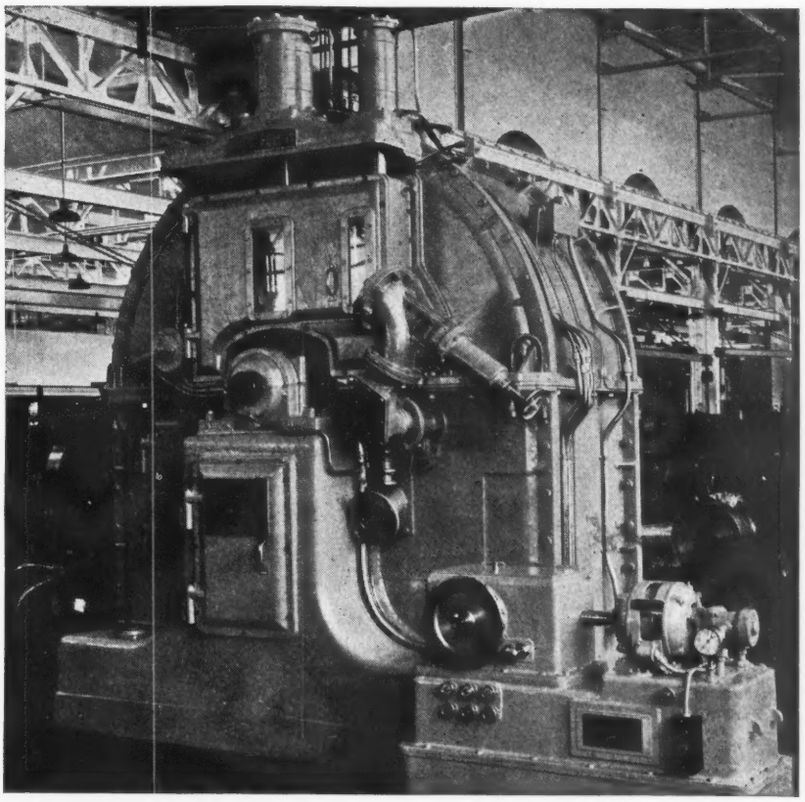
The "free-floating," frictionless meter mechanism of the ADSCO Flow Meter transmits the flow to a direct reading, evenly divided chart that indicates, records and integrates the steam output from boilers—boiler feedwater consumption—compressed air or gas consumption.

It provides the basis for the sale of steam in district heating work—determines steam consumption of auxiliaries—allocates steam consumption to departments or equipment — determines the flow of other fluids in any pressure system in which orifices, flow nozzles or venturi tubes may be used.

Sturdily built to resist sudden overloads or reverse flows. Available with recording chart, indicating scale and integrator counter to totalize the flow or in other combinations of these three devices. Write for Bulletin No. 35-83PR.

AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA, N.Y.
IN BUSINESS OVER SIXTY YEARS

BAKER-PERKINS, INC., *build the "largest American high capacity automatic centrifugal." Picture shows an HF2000 (82" diameter) Automatic ter Meer Centrifugal Clarifier for clarifying a difficult organic slurry.* SKF *Sphericals give complete satisfaction.*



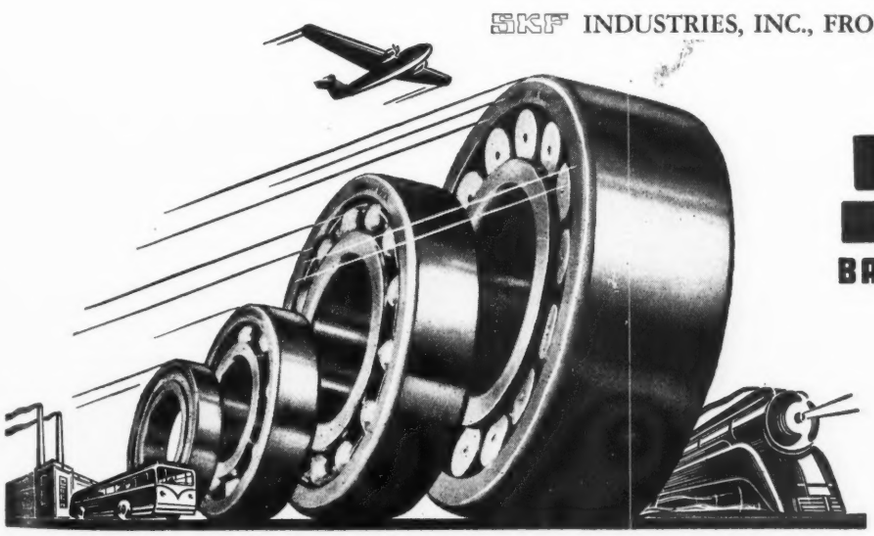
SKF

Bearings Help

CENTRIFUGALS DO MORE

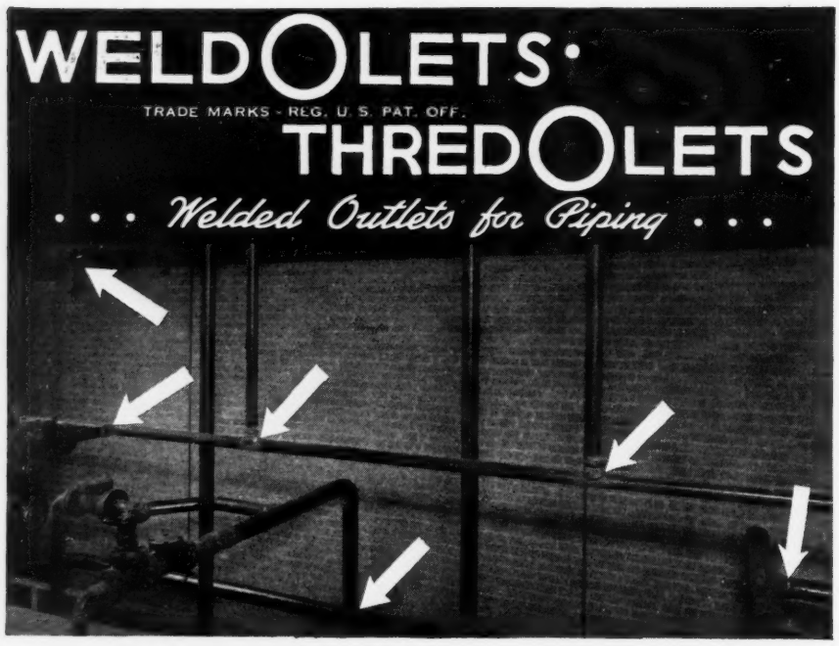
Do you know what it means to feel the weight of an 8,000 lb. basket carrying a 3,000 lb. load at 600 r.p.m. year in and year out? The SKF Spherical Bearings on this ter Meer Centrifugal know, but they don't mind it a bit. Why should they? With their built-in alignment, high capacity, long life, and low maintenance costs, *they're built for any job—even yours—anywhere.* 4784

SKF INDUSTRIES, INC., FRONT ST. & ERIE AVE., PHILA., PA.



SKF

BALL & ROLLER BEARINGS



The Right Branch "Take-offs" for Any Welded Piping System

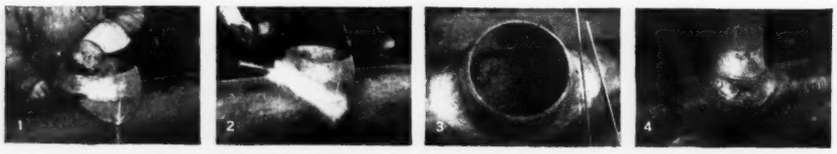
BONNEY WeldOlets and ThredOlets provide the proper method of making branch pipe connections in any piping system. Engineers recommend them because they provide absolutely leak-proof junctions, which because of their patented design are of full pipe strength and reduce turbulence and friction to a minimum.

Contractors use them because they may be installed before or after the erection of the main line . . . . because they eliminate all templets . . . . because they eliminate all cutting and fitting of the main pipe . . . . and last, but not least, because they are economical in first cost and in installation time.

Bonney WeldOlets and ThredOlets are recommended for all commonly used pressures and temperatures on all types of piping installations. They have been used and are in operation on a 600 lb. ,300° water line; on a 2500 lb. helium piping system; on CO_2 refrigeration piping at 1200 lbs., which was tested in excess of 2500 lbs. to mention only a few of hundreds of installations. Test sections including WeldOlets and ThredOlets have been stressed to 6000 lbs. without failure.

The next time you have a piping job in your plant — whether new construction or maintenance—insist on Bonney WeldOlets and ThredOlets. And in the meantime, get complete details about them. Write for Bulletin WT29 . . . . today.

As Easy As Lighting Your Pipe



(1)—Select the position of the outlet, rub the fitting over the pipe several times to remove scale, mark center lines and tack the WeldOlet or ThredOlet into position. (2)—The fitting is then welded into place by the electric-arc or oxy-acetylene method. A junction of full pipe strength and a leak-proof joint is the result. (3)—Where the outlet is 2" or larger the button should be removed after the welding operation. On small sizes the fitting is used as a templet and the hole is cut in the main pipe first, either with a hole saw, the torch or by drilling. Inspection of the inside of the joint is possible by using WeldOlets and ThredOlets, allowing the removal of all scale, welding metal, etc. (4) The branch line is then welded into position. In the event that a ThredOlet is used the branch pipe is threaded and screwed into place.

BONNEY FORGE & TOOL WORKS
Forged Fittings Division - Allentown, Pa.
Forged by the Makers of
The Finest that Money Can Buy
BONNEY TOOLS

New Plant Equipment

(*Continued from page* 128)

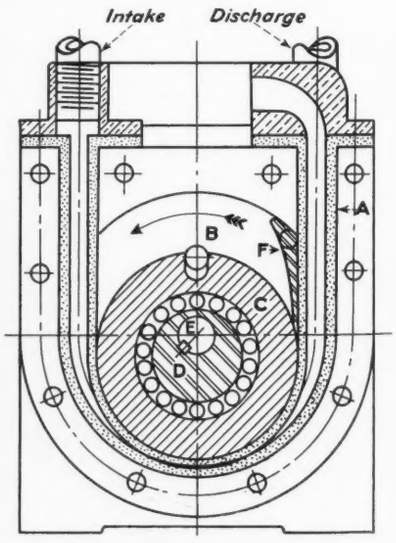
simultaneously from one point, (2) inaccessible or dangerously located bearings are conveniently lubricated at will, (3) lubrication of complete machinery is speeded, and (4) machines may be lubricated while operating. On equipment involving larger number of bearings, lubrication systems can be used in relays, each system or relay lubricating a maximum of twenty bearings. Any type of manually or power-operated high-pressure grease gun can be used. *Alemite Div, Stewart-Warner Corp, 1826 Diversey Parkway, Chicago, Ill.*

Synthetic Gaskets

AMERIPOL, synthetic rubber, is proving satisfactory material, according to maker, for various forms of gaskets and rings assembled with machines to keep oil or grease confined in bearings. These products are made either by molded or lathe-cut methods. *B F Goodrich Co, Akron, Ohio.*

Vacuum Pressure Pump

HUBER PUMP DESIGNED so that liquid going through pump does not come in contact with any metal pump-parts. There is practically no wear on internal moving parts and occasional replacement of tubing is only maintenance required. Pump is made to take care of capacity requirements specified from $\frac{1}{10}$ to 50 gpm. No check valves necessary on double-stage pump, and no gaskets or stuffing boxes are used. In operation, drive shaft *E* rotates in direction



indicated by arrow. Rotor *D*, being off center, pushes compressor ring *C* against tube *A*, a distance equal to inside diameter of tube, closing it, as shown in drawing. This action moves along from intake to discharge side. As compressor ring releases, tube expands back to its normal

THE COST OF VALVE REPLACEMENT includes:

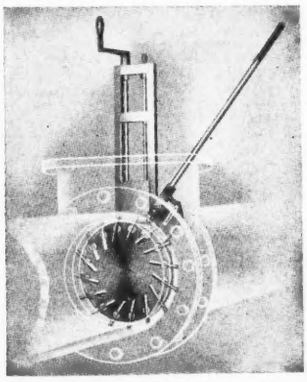
Cost of new valve . . . . . ?
Number of times valve can be reseated ?
Time lost for removal or replacement ?
Labor for removal or replacement . . ?
Pipe section replacements . . . . ?
Remaking tight connections . . . . ?
Truing up seats of new valves . . ?

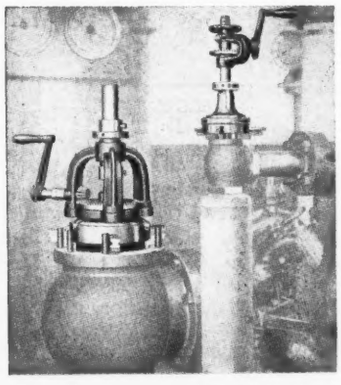
?

FIGURE IT OUT FOR YOURSELF

It will add up to this:

IT'S A LOT CHEAPER TO RESEAT A VALVE THAN REPLACE ONE . . .





INVESTIGATE THE LOW COST DEXTER WAY *for gate valves—globe valves—pump valves—*

The operation of reseating with a Dexter Valve Reseating Outfit costs so little that comparison with *any single item* involved in replacement definitely proves the economy of reseating. As a matter of fact the saving of only a few new valves is sufficient to pay for a complete Dexter outfit. Many plants are saving thousands of dollars in service the "DEXTER WAY" *—without taking valve from pipe line.*

HERE ARE SOME OF THE SAVINGS EFFECTED

—o—

Elimination of waste in steam, air, water

Elimination of valve removal and reassembly

Elimination of delivery problem on new valves

Save time — reseating jobs completed in a few minutes

Save money by restoring present valves to new condition

GET ALL THE FACTS *TODAY*

Now is the time to keep valves in prime condition to meet continuous service demands without leakage or failure. Send at once for complete details of Dexter Valve Reseating Machines as contained in 32-page fully illustrated Catalog No. 40.

THE LEAVITT MACHINE CO.
ORANGE, MASS.

THE LEAVITT MACHINE CO.
Orange, Mass.

Kindly send without obligation a copy of your Catalog No. 40 describing Dexter Valve Reseating Machines.

Name .....

Position .....

Company .....

Address .....

Non-Return Valves for TURBINE BLEEDER LINES

Balanced Action . . . Davis Non-Return Valves have finely balanced action through use of a counterweighted lever which balances disc assembly. Rugged construction insures smooth operation and long, trouble-free service. For extreme operating conditions, an outside oil dashpot is available. Balanced spring-loaded valves can also be furnished for non-return service.

Straight Flow . . . Disc swings up so that the direction of flow is in a straight line, without obstruction. Pressure drop across Davis Non-Return Valves is negligible.

Auxiliary Control . . . Either an auxiliary trip-lever or an oil cylinder can be furnished on Davis Non-Return Valves to provide emergency closing when the turbine oiling system fails. Reestablishing oil pressure releases auxiliary closing force and valve is free to operate as a balanced check valve.

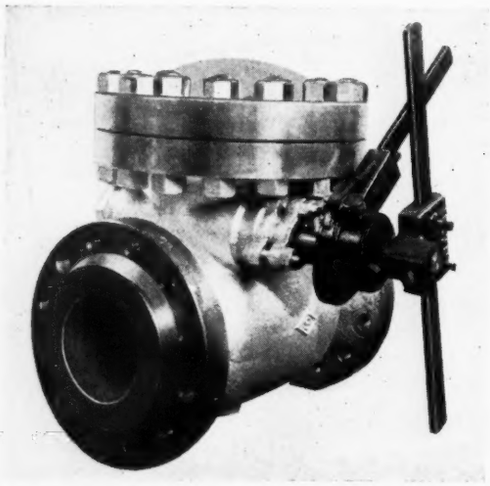
For Pressures up to 600 lbs. Sizes from 3" to 24". Steel or semi-steel bodies, with bronze, monel, or stainless steel trim.

Write for Complete Data. DAVIS REGULATOR CO., 2540 S. Washtenaw Ave., Chicago, Ill.

At Top—Davis No. 134 Balanced Check Valve. Simple in design, positive in action and dependable in service.

Right—Davis Non-Return Valve, equipped with auxiliary oil control cylinder for emergency closing.

Below—Davis Balanced Check Valve, with trip lever for auxiliary operation.

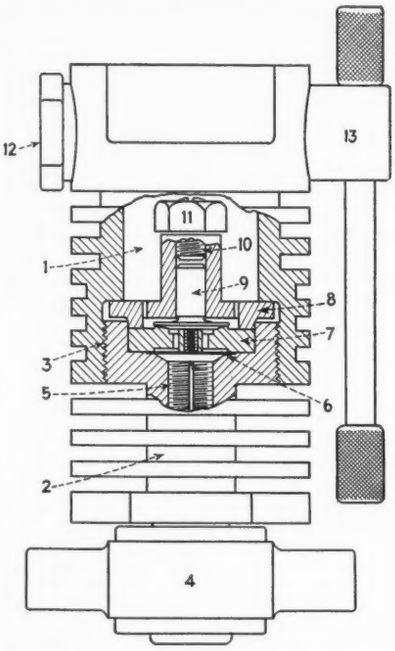


DAVIS REGULATOR COMPANY

diameter, producing high vacuum. This permits fluid or gas to flow into tube, which is discharged with each revolution of drive shaft. Compressor ring *C* does not wear tubing as it is pushed out radially, by the rotor, and cannot revolve. Tube guide plate *F* and pump casings *B* prevent tube, while under pressure, from expanding beyond normal diameter. *Huber Pump Div, Downington Mfg Co, Downingtown, Pa.*

Diesel Indicator

KIENE DIESEL INDICATOR provides means of checking maximum and compression pressures in less than half time usually required, according to maker. Consists of cylindrical pressure chamber (1) attached to finned cylindrical body (2) by means of thread (3). To latter is attached indicator cock wing nut (4). Body is drilled through and tapped, and short stainless-steel stud is used to attach indicator cock



plug to body, while upper part of tapped hole contains threaded brass filler (5) in which are cut slots. Above this is copper screen (6). Upper part of body is recessed to receive seat piece and center valve guide (8). This guide in turn centers valve (9) and limits its motion by means of stop screw (10), which is locked by means of nut (11). Gage is attached to bolt (12), which is secured by nut (13). Bolt and nut are fitted into body of pressure chamber (1) by tapered ground joints. *Kiene Diesel Accessories, 3836 Freemont St, Chicago, Ill.*

Acetylene Generator

OXWELD MP-10 WILL DELIVER 30 cu ft of acetylene per hr, and is suitable for welding metal up to $\frac{3}{8}$-in. thick, and for cutting steel up to 5-in. thick. Generator can be recharged easily and is simple to operate.

THERE GOES THE "AMBULANCE"!

—rolling out with emergency shipments of B&W Seamless Steel Tubes. B&W Distributors are able and eager to guard their reputations for unfailingly prompt deliveries.

B&W BOILER TUBE DISTRIBUTORS

ALABAMA	Mobile — Marine Specialty Co., 57 No. Water St.	NEW YORK	Buffalo — Beals, McCarthy & Rogers, Inc. New York — John B. Astell & Co., Inc., 90 W. Broadway
CALIFORNIA	Los Angeles — A. M. Castle & Co., 2300 E. 55th St. San Francisco — A. M. Castle & Co., 800 Indiana St.	OHIO	Cincinnati — Williams & Co., Inc., 1921-1927 Dunlap St. Cleveland — Williams & Co., Inc., 3700-16 Perkins Ave. Columbus — The Ross-Willoughby Co., 269 W. Spring St.
COLORADO	Denver — Mine & Smelter Supply Co., 1422 17th St.	OKLAHOMA	Tulsa — W. C. Norris Mfg. Co., Inc., P. O. Box 1188
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INDIANA	Fort Wayne, National Mill Supply Co., 207-13 E. Columbia St. Indianapolis — W. J. Holliday & Company	TENNESSEE	Memphis — J. E. Dilworth Co.
IOWA	Des Moines, Globe Mach. & Sup. Co., 205-11 W. Court Ave.	TEXAS	Amarillo — Clowe & Cowan, Inc. Dallas, Briggs-Weaver Machinery Co., 309 No. Market St. Dallas — Continental Supply Co., Continental Bldg. El Paso — Mine & Smelter Supply Co. Houston, Houston Oil Field Material Co., 1524 Maury St. Lubbock — Clowe & Cowan, Inc. Wichita Falls — The Bradford Supply Company
LOUISIANA	Lake Charles, Murray-Brooks Hardware Company, Ltd. New Orleans — C. T. Patterson Co., 800 So. Peters St. Shreveport — Bethlehem Supply Company		
MARYLAND	Baltimore, John McKenzie & Co., Key Hway. & Boyle St.		
MASSACHUSETTS	Boston — Brown-Wales Company, 493 C St. Holyoke — Massachusetts Supply Corp.	UTAH	Salt Lake City, Mine & Smelter Supply Co., 121 W. 2nd South St.
MICHIGAN	Detroit — Service Steel Co., 1435 Franklin St.	VIRGINIA	Norfolk, Empire Machinery & Supply Corp., 409 Water St.
MISSOURI	Kansas City — Langdon Supply Co., 1317 Union Ave. St. Louis — Sligo Iron Store Co., 1301-1403 No. 6th St.	WASHINGTON	Seattle — A. M. Castle & Co., 32 W. Connecticut St.
NEW MEXICO	Hobbs — Continental Supply Co.		

THE BABCOCK & WILCOX TUBE COMPANY, BEAVER FALLS, PA. TA—1143

BABCOCK & WILCOX TUBES

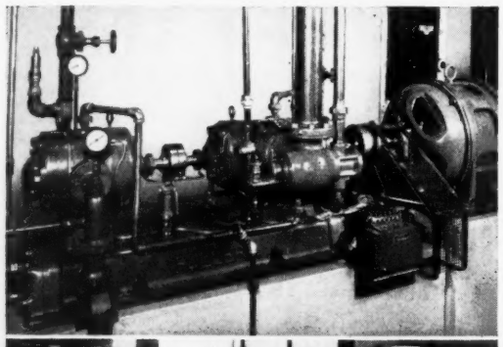
HOT FINISHED COLD DRAWN ALLOY STEELS CARBON STEELS

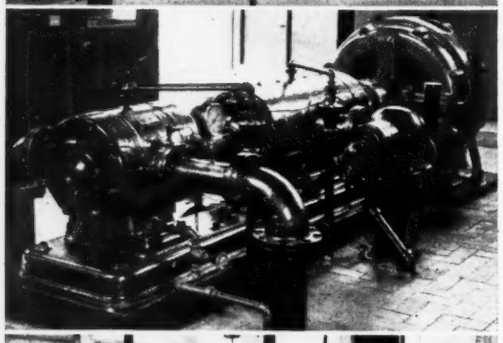
FULLER ROTARY COMPRESSORS

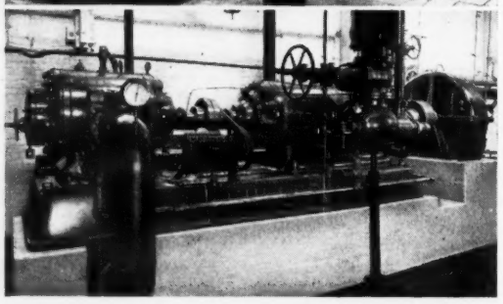
BUILT FOR
TROUBLE-FREE
OPERATION

Rush! Rush! Rush! More speed all along the line. That's the cry today. But speed is not enough . . . equipment must be able to stand up under the most severe operating conditions . . . service must not be interrupted. Breakdowns—delays—time out—all mean loss of vital production and money out of pocket.

With this thought uppermost, only the best of materials and workmanship go into the makeup of Fuller Rotary Compressors. They're built for trouble-free operation and performance records prove them to be just that. When, after long, gruelling operating periods, inspection and check-up is desired, the machine design permits doing this quickly and easily.







Direct drive
Easy to operate
Low maintenance
Simple foundations
No bearing take-up
Small space required
No air-line pulsations
Parts readily accessible
Sturdy yet light in weight
Blades automatically compensate for wear
No valves to leak or seats to grind
Unnecessary bulk eliminated
Maintained capacities for the life of the machine
No multiplicity of parts requiring frequent attention and replacement.

Fuller Rotaries are built for capacities to 1800 C. F. M. actual free-air delivery, pressures to 125-lb. gage.

FULLER COMPANY

CATASAUQUA, PENNSYLVANIA

Chicago: 1118 Marquette Bldg. San Francisco: 320 Chancery Bldg. C-59

FULLER

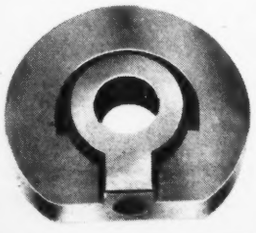
PIONEERS OF HIGH-EFFICIENCY ROTARY COMPRESSORS

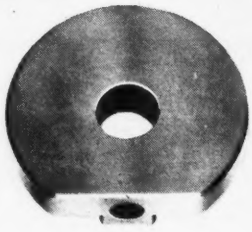
Generation of acetylene is started, set for regular operation, and stopped, by rotating single pair of operating handles at generator

top. Once operating handles have been set, acetylene generation proceeds automatically. Pressure of acetylene delivered to blowpipe is controlled by regulator which forms integral part of generator, and separate pressure gage indicates pressure at all times within generating chamber. Designed for maximum portability, from standpoint of weight and height, and can be readily moved about shop. *Linde Air Products Co, 30 East 42nd St, New York, N. Y.*

Bearings

"SELFLUBE" POROUS BEARINGS are made from powdered alloys, moulded to size in shape desired then baked, and finally quenched in oil. Illustration shows top and bottom views of one new design. Bearings have average porosity of 35%, enabling them to store large amount of oil. This helps form a protective continuous oil-film on bearing surface. Units have tensile strength of over 35,000 lb per sq in., and



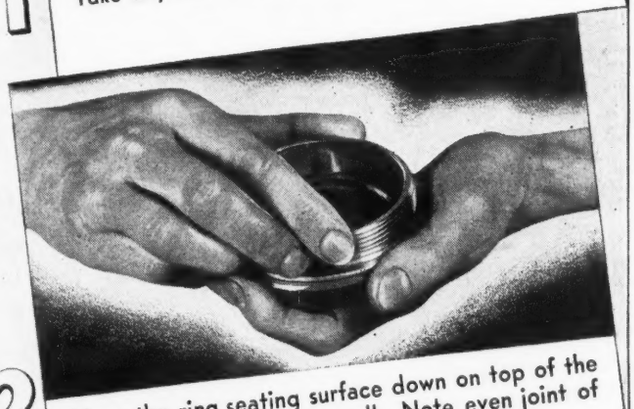


SIMPLE TEN-SECOND TEST

of Factory Stock Parts PROVES DARLING SUPER-MACHINED SURFACES

—and shows what "tight-closing" really is!

1 Take any new Darling valve disc and seating ring.



2 Place the ring seating surface down on top of the disc face—forming a "cup." Note even joint of smooth uniformly-machined surfaces.

3 Pour water into the "cup". Though gravity alone holds the ring to the disc, not a drop of water escapes!

4 Even when you *revolve* the ring on top of the disc, the closure remains water-tight!

It's another proof of

DARLING PERFORMANCE!

Once again, pictures speak louder than words. Nothing we could say about Darling's accurate machining would be half so eloquent as the proof in this test—showing surfaces so smooth they make a water-tight seal simply by *"meeting."*

Darling devotes this same accuracy to every manufacturing step, from furnace to finish. Results: longer life, easier operation, and welcome freedom from maintenance expenses. Specify Darlings for your next valve installation!

DARLING VALVE & MANUFACTURING CO.

Williamsport, Pa.

New York Philadelphia Houston Toledo Pittsburgh
Huntington, W. Va. McPherson, Kan.

DARLING

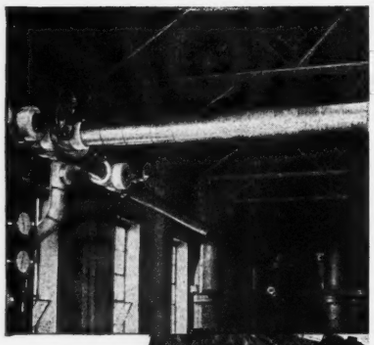
DENSE-METAL GATE VALVES

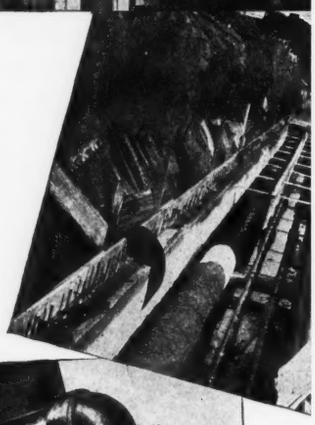
PIPES . . . PIPES . . . PIPES

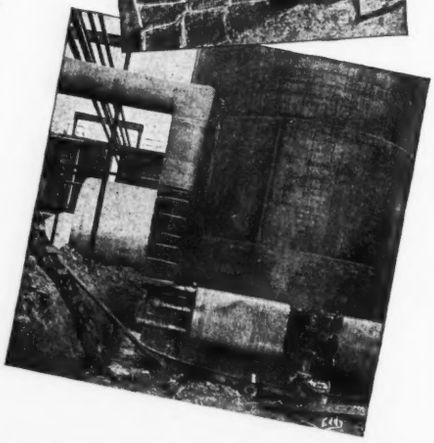
B-H

Indoors,
Outdoors,
Overhead,
or Underground

BALDWIN-HILL
No. 100
Pipe Covering







Reduces Waste . . . Steps up Efficiency . . . Cuts Cost of Piping Steam

With defense and all other industry working at top speed, more and more strain has been put on the facilities for the generation and transportation of steam. To cover this latter requirement, B-H No. 100 Pipe Covering has proved highly efficient, long lasting and most economical. It is effective up to 1000° F. and being made of chemically stable B-H black Rockwool it has a low alkalinity factor which insures long life and peak efficiency under severe heat and moisture conditions. *Send for New Bulletin giving complete engineering data and specifications for application.*

Photos from Top to Bottom:

B-H No. 100 Pipe Covering on 6" Steam Line finished with 28 gauge metal jacket.

B-H No. 100 Pipe Covering 3" thick, on 12" Underground Steam Line, finished with 45 lb. roofing felt.

B-H No. 100 Pipe Covering on 12" Pipe finished with B-H No. 1 Insulating Cement and B-H Weatherseal.

B-H No. 100 Pipe Covering on Steam Traced Lines.

BALDWIN-HILL CO.

575 Klagg Ave.,
Trenton, N. J.

New York . . . Boston . . . Chicago
Kalamazoo, Mich.

A Complete Line of Heat Insulation Products

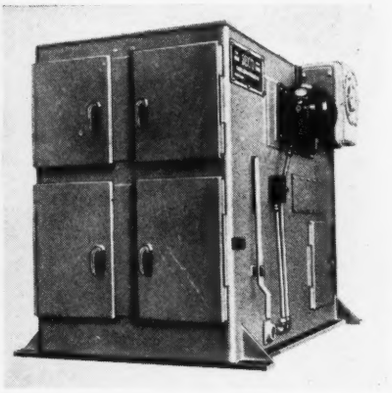
B-H

B-H Black Rockwool BLANKET . . . B-H MONO-BLOCK
B-H No. 100 PIPE COVERING . . . B-H MINERAL FELT
B-H No. 1 INSULATING CEMENT . . B-H WEATHERSEAL
and other heat insulations effective up to 2000° F.

have low friction coefficient which prevents, according to maker, excessive temperature, speed reduction, noise and shaft scoring. *Keystone Carbon Co, 1935 State St, St. Marys, Pa.*

Coal Scales

SECO COAL SCALES have endless belts, specially molded with integral side flanges. Special feeder facilities belt replacement when belt does wear out. Stainless-steel weigh hopper is butt-welded to resist corrosion and wear. Action of toggle mechanism waits until all coal is off gate, then



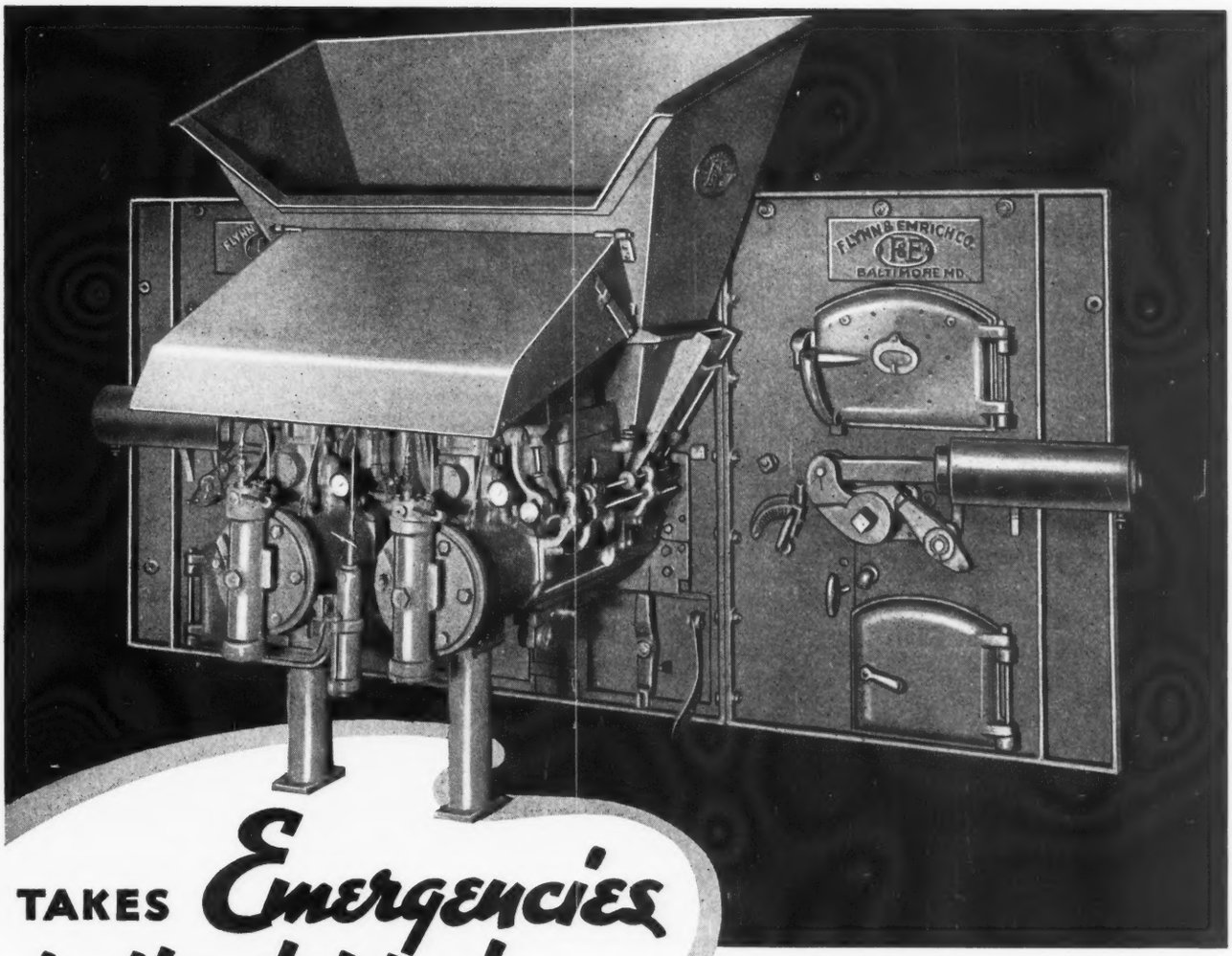
effects positive closing under 460-lb pressure. Control apparatus inclosed in dustproof casing, with control shafts passing through positive dust seals. In event of electrical failure, coal can be bypassed instantly, by merely raising lever. Lowering lever closes bypass, and lead seal gives definite indication that bypass has been used. *Stock Engrg Co, 9805 Theodore Ave, Cleveland, Ohio.*

Smoke Detector

WORNER SMOKE DETECTOR is conventional electric-eye device used to detect smoke passing through ducts, etc., of air-conditioning systems. When predetermined density of smoke (about 2% interruption of illumination per foot width of duct) passes through beam, relays operate, causing fan to stop and giving audible or visual alarm. Dampers of air-conditioning equipment can be interconnected, causing air passage to be completely blocked off, permitting normal operation of thermally operated fire-extinguishing equipment if necessary. *Worner Products Co, 1019 West Lake St., Chicago, Ill.*

Distance Relay

REDESIGNED RELAY INCORPORATES new features to simplify testing and maintenance. New factors include timing unit with cast-metal base in which mounting bosses and bearing supports are brought together into single unit. Testing is made easier by having end leads of each current and potential coil brought out separately. Taps on ohm unit have been eliminated to simplify lay-



TAKES *Emergencies in its stride!*

The Series 70, Double Retort, "F&E" Underfeed Stoker with Electro-Hydraulic Drive. Designed for boilers ranging from 10,000 to 40,000 lbs. of steam per hour. Incorporates the famous patented "F&E" Interval Timer Governor, the Fuel Bed Regulator, the Sliding Bottom Retort and Full-Stroke, Full-Speed Ram Action.

WHEN the going is tough — that's when the real value of dependable "F&E" Stokers asserts itself. For an "F&E" Stoker is not a baby that needs pampering—it's built for hard work. It is a dependable source of power, with features designed to weather the storm of ever increasing demands for more power for greater production.

If fuel and fuel burning equipment are causing you concern—consult the "F&E" representative in your territory and learn how "F&E" Stokers can assure you dependability, efficiency and economy in your boiler room.

★ There is an "F&E" Stoker for every type boiler that produces steam for power or heat—industrial or commercial. Write manufacturer for descriptive literature.

F&E

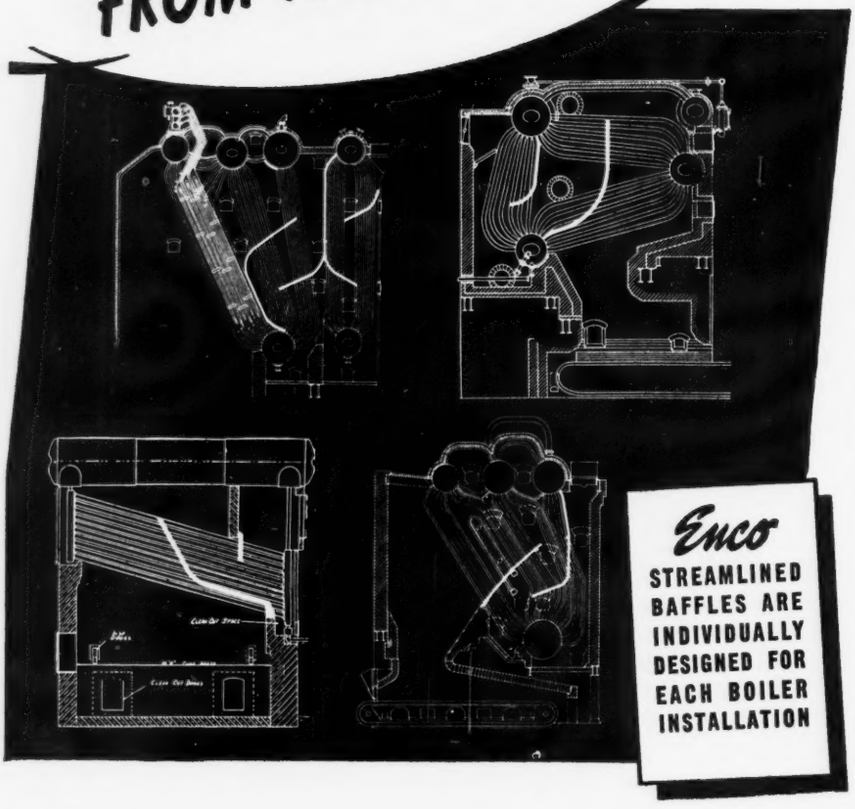
STOKERS

Hydraulic And Steam Drive are manufactured and sold by

FLYNN & EMRICH CO., BALTO., MD.

Representatives in Principal Cities

THE Quickest WAY TO GET MORE STEAM FROM YOUR BOILERS



Enco STREAMLINED BAFFLES ARE INDIVIDUALLY DESIGNED FOR EACH BOILER INSTALLATION

RIGHT now, when most power plants are taxed to the limit, the type and construction of the baffle walls in your boilers are of the utmost importance.

That much needed extra capacity, plus lowered operating and maintenance costs can be obtained by the installation of ENCO Streamlined BAFFLE WALLS. We've spent 25 years perfecting baffle wall design and materials to a point where they greatly influence boiler performance.

Write for Bulletin BW-40 or, for quick action, send blue prints and operating data. There is no obligation.

THE ENGINEER COMPANY
75 WEST STREET • NEW YORK, N. Y.

Enco Streamline Baffles
PRODUCED EXCLUSIVELY BY THE ENGINEER COMPANY

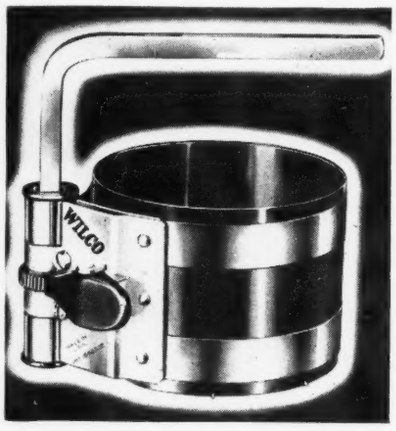
out design and to avoid necessity of extra tap-checking by operator. No changes have been made in operating principles of relay. Induction-cylinder design of ohm and starting units has been retained, as has stainless-steel wire worm of timing unit. New types of relays include both 3-phase and single-phase forms, with or without overcurrent units, and 3-phase ground-fault form. *General Electric Co, Schenectady, N. Y.*

Oil Tank Cleaner

SILOO SOLVENT is positive-acting treatment for cleaning fuel-oil tanks and heating equipment. Developed as antidote for clogged oil filters and pipelines. Said to dissolve various accumulations in such a manner that will not affect efficiency of heating plant. One quart of solvent is used to each 150 to 275 gals of fuel oil. Application of solvent is preferable immediately before tank is replenished with new oil, so that complete amount will reach fuel tank. *Petroleum Solvents Corp, 331 Madison Ave, New York, N. Y.*

Ring Compressor

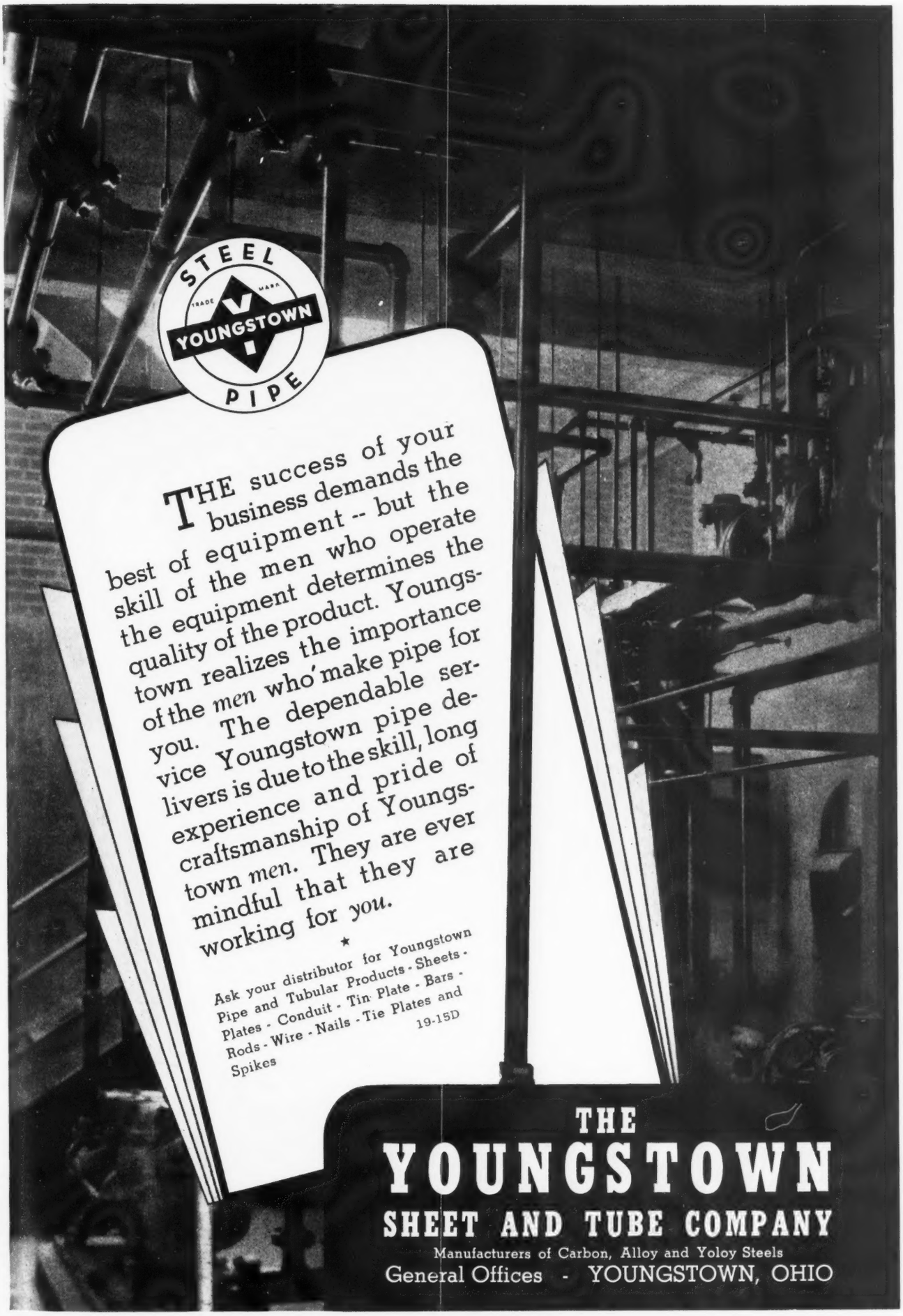
WILCO RING COMPRESSOR is maintenance tool for diesel operators. Used when replacing cylinders, compresses piston rings so that piston can be inserted into cylinder



bore. Features of tool are two tension bands and positive ratchet lock. Crimps in lower edge of compressor make it impossible for tool to slide down inside cylinder. *Wilkening Mfg Co, Philadelphia, Pa.*

Metal-Clad Switchgear

DESIGNED FOR OIL REFINERY SERVICE, switchgear has all features of G-E standard metal-clad switchgear in general industrial service, plus a number of features to meet special requirements of industry. Removable front and rear panels are fitted against a neoprene-covered felt gasket retained in protecting channel. Gasket combines compression qualities of felt with gas-resisting qualities of neoprene. Junctions between floor plate, side sheets, and top cover are sealed with compound retained in built-in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THE success of your business demands the best of equipment -- but the skill of the men who operate the equipment determines the quality of the product. Youngstown realizes the importance of the men who make pipe for you. The dependable service Youngstown pipe deliverers is due to the skill, long experience and pride of craftsmanship of Youngstown men. They are ever mindful that they are working for you.
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"Baerite" SIMPLIFIED WATER TREATMENT SERVICE

Completely

- ✓ PROTECTS AGAINST BOILER AND LINE SCALE, RUST AND CORROSION
- ✓ PROTECTS AGAINST BOILER FOAMING PRIMING AND CARRY OVER
- ✓ PROTECTS AGAINST EFFICIENCY-LOSS, DELAY AND *DETERIORATION

*. . . any deterioration due to water conditions.

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"Baerite" WATER TREATMENT SERVICE

THE SIMPLIFIED COMPLETE WATER SERVICE

WATER TREATMENT COMPANY of AMERICA

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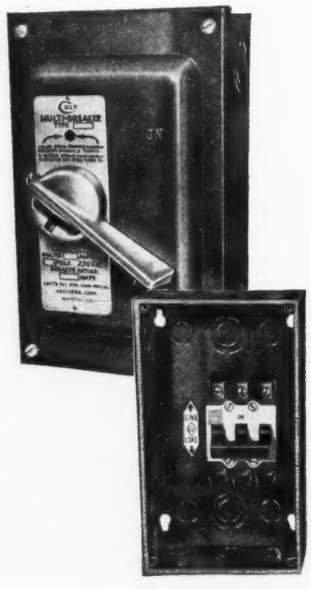
channels. Oil circuit breaker in equipment can be raised or lowered to connected or disconnected position without opening front door. Window allows operator to determine visually position of breaker. External surfaces of equipment have special corrosion-resistant finish and inner surfaces of roof and side sheets are lined with cork to prevent condensation. *General Electric Co, Schenectady, N. Y.*

Turbine Pump

DESIGN IMPROVEMENTS ANNOUNCED in company's line of vertical turbine pumps include changes in guide vanes, function of which is to alter, from horizontal to vertical, flow direction of liquids being pumped. Previous pump practice dictated that guide vanes be constructed as thin as possible on advance edge, on theory that the less metal the fluid strikes, the less resistance would be encountered. Company engineers discovered that because fluid being discharged by impeller element flows across guide vanes at various angles (instead of always directly across advance edge) eddy-friction-losses are encountered, reducing pump efficiency. With advance ends bulbous shape, it was found that, regardless of fluid direction from impeller, direction would be always substantially tangential to vane surface. Also because of bulbous-shaped vanes, with recessive curve at rear, eddy currents are not developed, according to manufacturer. Present owners of turbine pumps need only replace bowl assembly to have features mentioned. *Pomona Pump Co, Pomona, Calif.*

Circuit Breakers

ADDITION OF TYPES M1 AND M2 industrial "Multi-breaker" to company line announced. Having advantage of lower price range, device can be supplied with either two or three poles, in ampere ratings from 15 to 100 for 230 *v*, ac, only. Breakers are fur-



Bat in Rope Runs WITH THE ROEBLING "4"!

The teamwork of the "Roebling 4" has produced the finest in elevator rope — Roebling "Traction Steel". It is a rope especially developed to assure maximum rope economy and safety.

Roebling "Traction Steel" assures lowest possible *general average* rope operating cost.

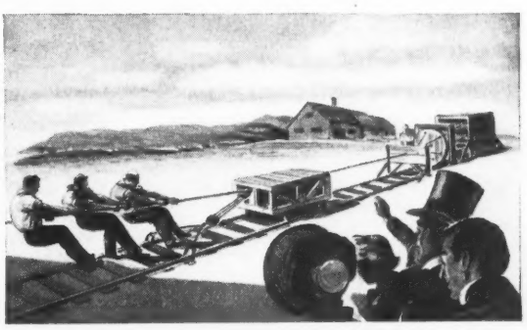
ROEBLING "Traction Steel" ELEVATOR ROPE

AMERICA'S FIRST WIRE ROPE!

Over 100 years ago John A. Roebling made America's first wire rope. In 1841 he founded the Roebling business.

In today's Roebling wire rope you get the benefit of over 100 years of experience — and of the painstaking care and exceptionally high standards of quality which are Roebling traditions.

Shown to the right is John A. Roebling's first crude wire rope making machine, used at his pioneer plant in Saxonburg, Pa.



ROEBLING 1841 1941 100TH ANNIVERSARY

JOHN A. ROEBLING'S SONS COMPANY TRENTON NEW JERSEY

Branches in Principal Cities Export Division: 19 Rector St., New York, N.Y., U.S.A. Cable Address: "Roebling's", New York

There's a revolution going on in BOILER FEEDING

A FEW TYPICAL USERS

DuPont Company, El Monte, Calif.
Holly Sugar Co., Torrington, Wyo.
Van Camp Milk Co., Angola, Ind.
Dry Zero Corp., Buchanan, Mich.
Champion Paper & Fibre Co., Saundersville, Ga.
Cannon Mills, Social Circle, Ga.
U. S. Naval Air Station, Pensacola, Fla.
Hotel Roosevelt, New Orleans, La.
Hiteman Leather Co., W. Winfield, N. J.
Union Laundry, Newark, N. J.

EVERY once in a while a brand new idea comes along that makes accepted methods look about as snappy as a 1910 automobile. It may be as simple as putting zippers on clothing and hand bags. But whatever it is, if it does a job better, or at lower cost, American Industry wants it — and *needs* it.

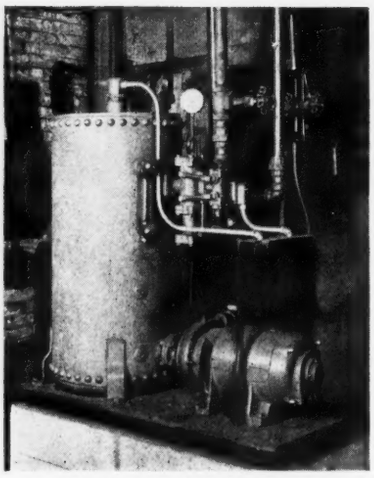
The Johnson "Pressure Equalizing" Pump is exactly that kind of a basically-better idea. It outmodes so completely every known method of pumping water to a boiler, that Johnson dares to claim that the "Pressure Equalizing" High Temperature Return System will:

1. **Cut pumping cost as much as 60%.**
2. **Cut fuel cost 10% to 15%.**
3. **Cut pump maintenance cost to the bone.**

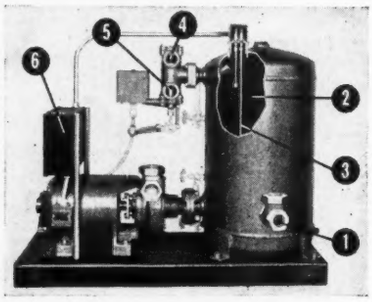
These savings are accomplished by the simple short-cut of admitting boiler pressure to the pump chamber while the pump operates. Eliminated is the task of fighting against boiler pressure — a task that requires considerably more horsepower, higher speed, and high-maintenance construction in the ordinary type of boiler feed pump.

So simple, so sound is the operating principle of this revolutionary new pump that leading firms and power plants have been quick to adopt it. Their wholehearted endorsement is proof that the "Pressure Equalizing" method, found exclusively in the Johnson Pump, can effect the same remarkable saving in your plant.

Write for new Bulletin

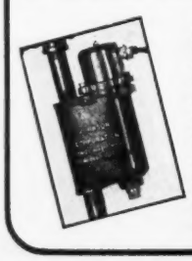


● Installation view of the Johnson No. 250 SH Pressure Equalizing Boiler Feed Pump. This unit is fully A.S.M.E.-approved, designed for boilers up to 250 Hp., 150 lbs. pressure. Smaller sizes are available, to suit every plant—for boilers as small as 30 Hp.



HOW IT WORKS—Condensate enters inlet (1) filling equalizing chamber (2) until water across electrodes (3) completes circuit to relay (6). This operates two way valve, admitting steam from boiler through inlet (4) thus equalizing chamber with boiler. Pump is started simultaneously—*its only task to raise water a few feet to boiler level, not overcome boiler pressure.* When contents are pumped into boiler, inlet (4) is closed, pump is stopped and steam is exhausted to a condensing receiver through port (5). Cycle then repeats.

TO COMPLETE YOUR BOILER FEED SYSTEM



● Use the automatic Johnson Boiler Water Level Control. Dependable, low-cost, easily installed. Utilizes new electrical operation — a perfect teammate for the Johnson "Pressure Equalizing" Pump. Can be used to control boiler feed pump, open make-up water valve, or sound low water alarm.

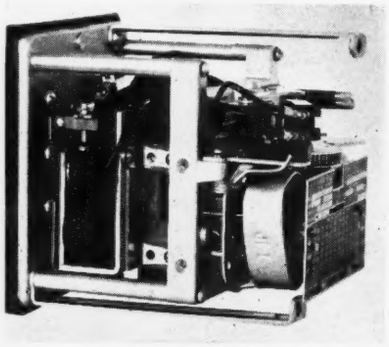
Products of The Johnson Corporation

885 WOOD STREET, THREE RIVERS, MICHIGAN

nished with both thermal and magnetic trip. Thermal trip provides time delay on small overloads, while magnetic trip assures instant operation on dangerous short circuits or high overloads. *Colt's Patent Fire Arms Mfg Co, Hartford, Conn.*

Relay

IMPROVED AC TRIPPING FORM of IAC relay, rated to interrupt 100 amp around a trip coil. Old design was based on carrying capacity of contacts, rated 50 amp for 2 sec. New design employs thicker contact-



brush and more massive contacts, which retain heat thrown off by arc, and permits rating of 100 amp for 2 sec. Trip coils with resistances up to 4 ohms can be safely handled with new relay, manufacturer states, though contact pressure is weakened when carrying current too long. *General Electric Co, Schenectady, N. Y.*

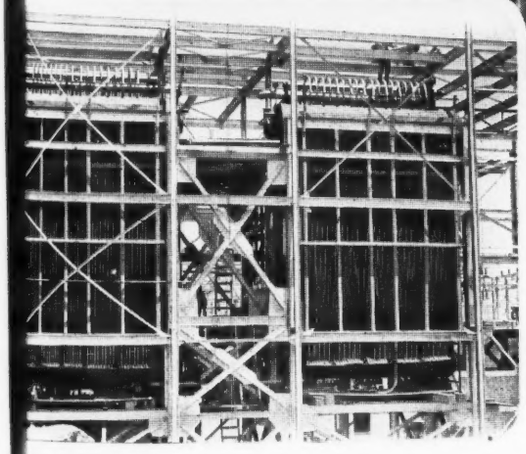
High-Speed Belt

GILMER-HEVALOID BELT is designed for high-speed precision work, according to maker. Process of impregnating cotton pulling element with latex (U. S. and foreign patents) is said to form material that is practically homogeneous. Non-slip surface results from direct contact of belt material with pulley face, giving high coefficient of friction. Pliability for use over small pulley diameters adapt belt for operation at speeds to 9000 fpm. *L H Gilmer Co, Tacony, Philadelphia, Pa.*

Water Heater

ALL-STEEL VERSION of company's copper-tube heater designed to supplement, not replace, the latter. Used to heat water and other liquids with steam and can be hooked directly to high-pressure steam lines without any reducing valves. Outer shell is heavy wrought-steel pipe. Two concentric smaller pipes are centered within, so that steam chamber is formed between outer wall of smaller pipe and inner wall of surrounding pipe. Water is admitted to central pipe, where it encounters spiral baffle which

DOUBLE SAFETY



These two boilers in the Municipal Power Plant, Glendale, California—200,000 lb. per hr., 750 lb./sq. in. pressure max., 825° temperature—will enjoy the double safety of ELECTRUNITE—used for boiler, superheater and water wall tubes.

for your Boilers —at Low Cost

● Safety against pressures is one thing. Safety against costly shutdowns—against lost operating time—against high maintenance costs—is another. But together they mean double safety.

That's what you want. And that's what you get when you specify Republic ELECTRUNITE Boiler Tubes.

Safety against operating pressures is insured by uniform wall thickness and by the sound ELECTRUNITE weld—proved in each and every tube by hydrostatic test at pressures within 20% of the minimum yield point of the steel (always far above code requirements).

Safety against lost time—against high cost—is insured by ELECTRUNITE'S service-proved long, trouble-free life and low upkeep cost.

No scale or pits—no scabs or slivers mar the glass-smooth surface, inviting corrosion to attack. Retubing time is shortened by work-accelerating uniformity in wall thickness, diameter, concentricity and ductility.

Get double safety at low cost for *your* boilers now and for all time by specifying Republic ELECTRUNITE Tubes. Steel and Tubes Division, Republic Steel Corporation, Cleveland, Ohio.

REPUBLIC STEEL DEFENSE FOR AMERICA

Republic ELECTRUNITE

REG. U. S. PAT. OFF.

Electric Resistance Welded Boiler, Condenser and Heat Exchanger Tubes

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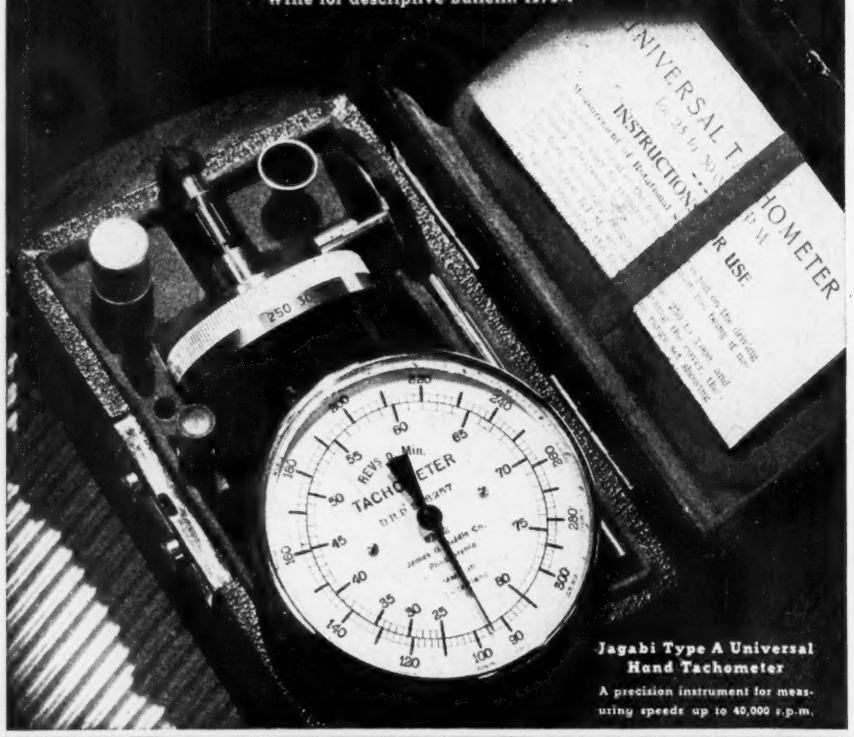
Instruments for Measuring Speed

Centrifugal, Chronometric and Vibrating-Reed Types

Write for descriptive Bulletin 1575-P



Jagabi Type A Universal Hand Tachometer

A precision instrument for measuring speeds up to 40,000 r.p.m.

JAMES G. BIDDLE CO.

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• QUICKLY •

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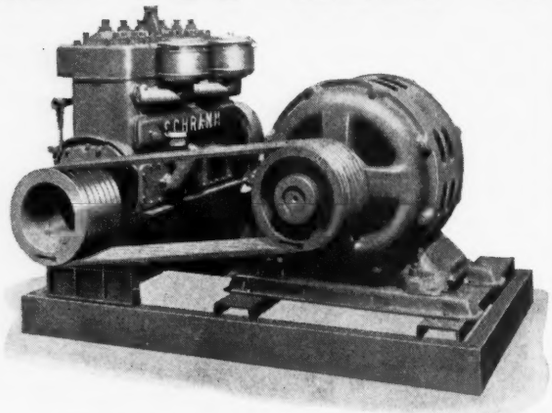
At minimum cost



SCHRAMM compressor with motor, on base. "V" belt drive with 100 hp. electric motor, displacement of 600 cub.ft. of air.

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SCHRAMM Stationary Air Compressors provide the means of supplying compressed air service right where it's needed for maximum convenience and use.

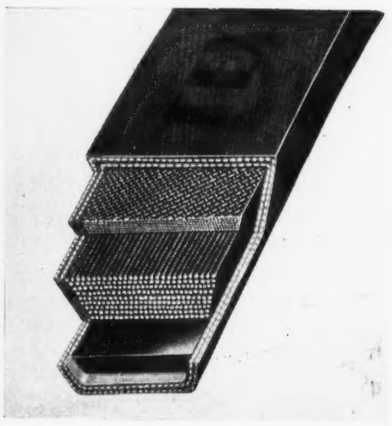
SCHRAMM, INC., WEST CHESTER • PA.

SCHRAMM UTILITY STATIONARY AIR COMPRESSORS

creates turbulence and increases length of travel in contact with heated wall. Water then returns to outlet through outer chamber, where another spiral baffle multiplies its length of travel and velocity along surface of hot steam-chamber. Unit will withstand steam pressures as high as 150-lb in standard types, and as high as 250 lb in special heavy-duty types. *Johnson Corp, Three Rivers, Mich.*

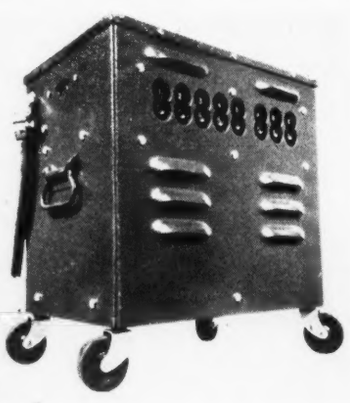
Multiple V-Belt

"SUPER 7" LAMINATED DESIGN now included in all Texrope belts made by company said to include more strength, flexibility, and longer life. Cords in new belt are smaller, permitting use of more cords per belt with resulting greater strength and less stretch. Each cord is individually imbedded in heat-dissipating rubber to reduce internal belt degeneration. Live rubber bottom-cushion absorbs impact of operation, central-cord-portion transmits power at effective pitch diameter, and bias-cut fabric prevents "dishing" and assures transverse stability, while 2-ply rubber-impregnated fabric cover prevents destructive agents from reaching vital belt elements. *Allis-Chalmers Mfg Co, Milwaukee, Wis.*



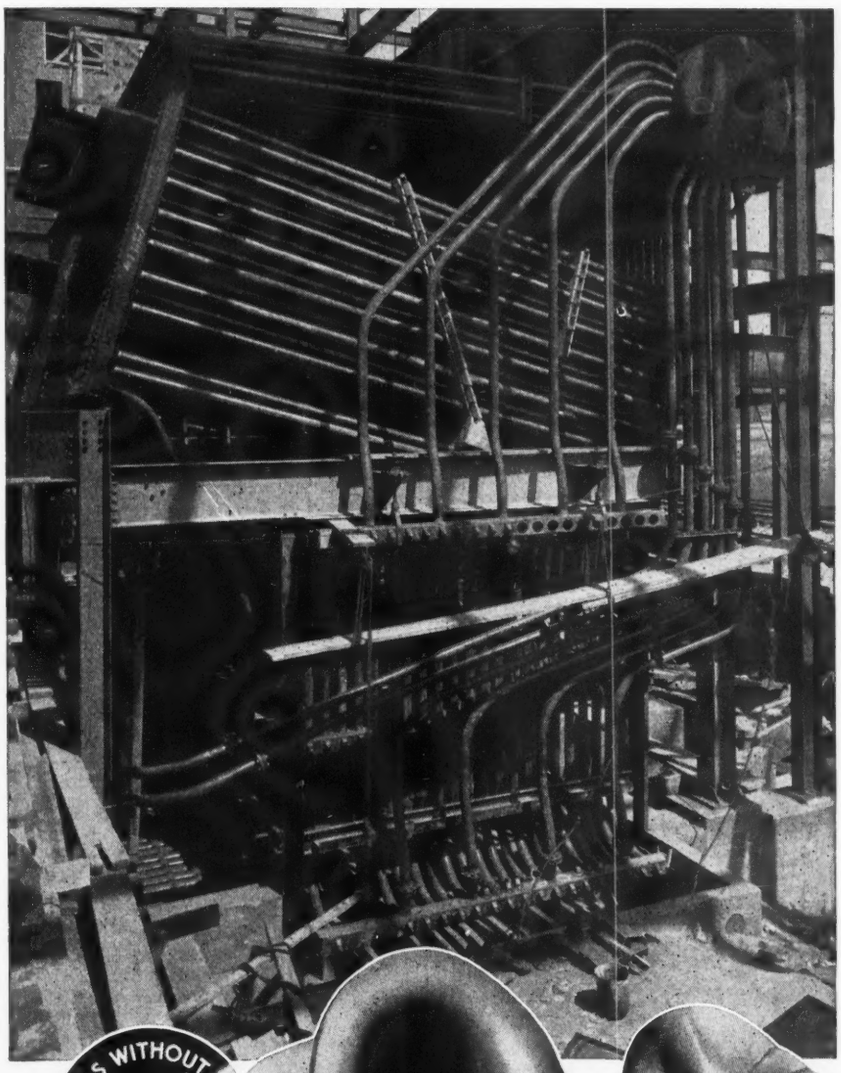
Welder

MIDGET MARVEL FLEXARC WELDER for welding light-gage metal, castings and drive shafts, general maintenance and production work. Welder comes complete with all accessories, which include electrode lead and



BOILER MAKERS SAY-

"They're the easiest working boiler tubes we've ever handled!"



THAT'S because every NATIONAL Seamless Boiler Tube is 100% annealed at the mill, before shipment. This controlled annealing process imparts uniformity of grain structure and assures just the correct balance between strength and ductility —and that's why boiler makers say they work easy, that they get truer bends. That's why they also withstand flaring, rolling and beading operations with no tendency to split or crack, thus preventing waste in time and material — speed up installation.

Each NATIONAL Seamless Boiler Tube is pierced from the highest quality killed open-hearth steel. Therefore, every tube is a homogeneous steel cylinder with uniformly high wall strength with no weld—no line of potential weakness to limit safe operating pressure. The piercing process itself is the severest commercial test of steel quality ever devised —and that's why you get consistently fine boiler tubes when you specify NATIONAL Seamless.

Write for complete data — our bulletin No. 12 will give you full engineering details on "America's Preferred Boiler Tubes."

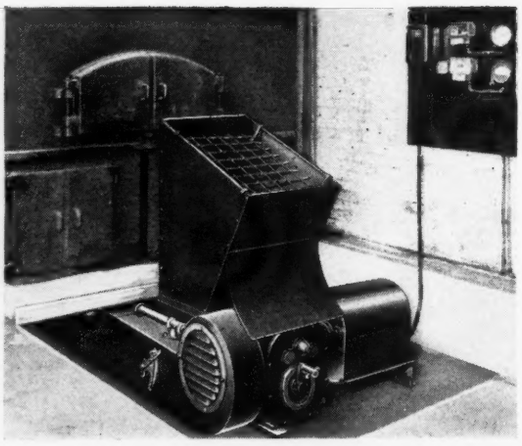
NATIONAL TUBE COMPANY

PITTSBURGH, PA.

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Export Company, New York

UNITED STATES STEEL

USE THE STOKER THAT MADE ITS FAME ON INDUSTRIAL APPLICATIONS



Simplest mechanically . . . the FREDERICK STOKER is especially rough, tough and rugged in construction . . . was built first and primarily to withstand the rigors of heavy duty industrial applications.

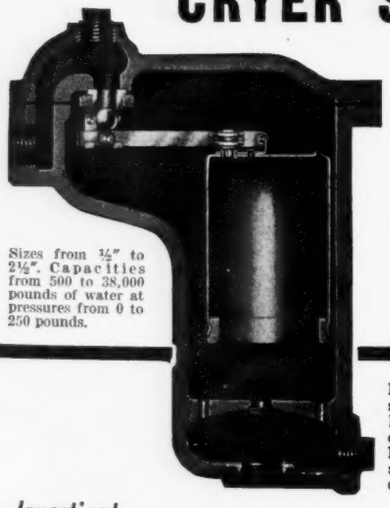
Among the many models in both screw and ram types you'll find a FREDERICK designed for your need—and with a long success record on similar jobs. Ask about it. No obligation, of course.

Frederick INDUSTRIAL STOKERS

Built by The FREDERICK IRON & STEEL CO., Frederick, Maryland . . . "Builders of Good Stokers for Over 23 Years".

COMPLETE LINE OF CENTRIFUGAL PUMPS FOR ALL PURPOSES
STEAM OPERATED ASH CONVEYING SYSTEMS • ASH STORAGE BINS

CRYER STEAM TRAPS



put an end to trap troubles, save steam, step-up efficiency . . .

TRY THEM!

Sizes from ½" to 2½". Capacities from 500 to 38,000 pounds of water at pressures from 0 to 250 pounds.

If you are having trouble with air binding, slow venting, dribbling on your steam lines, you'll save yourself a lot of headaches by installing CRYER INVERTED BUCKET STEAM TRAPS—and you'll save steam as well as reduce maintenance costs.

These positive acting, quick venting, non-binding, accessible units insure proper operation under all conditions. They are proof against interference with normal operation by sudden surges—are long lived, efficient and guaranteed for performance.

Get *all* the facts TODAY! Send for bulletin giving complete details. A trial will convince you that the "CRYER" is the trap you've been looking for.

Investigate
THESE TIME AND MONEY SAVING FEATURES . . .

- . . . all mechanism is removable without disturbing piping
- . . . all wearing parts are of stainless steel
- . . . venting is quick, positive and assures dependable drainage
- . . . installation is simple and easy

Built by manufacturers of Steam Specialties for over 40 years.

We carry all sizes of traps, and repair parts, of the line formerly known as the J-M Ball Steam Trap.

CRYER TRAP AND VALVE CO., INC.
366 Madison Avenue, New York, N. Y.

holder, work lead, helmet and electrode supply. Sensitive adjustment of welding current over range from 20 to 140 amp provided by 15 steps with correctly proportioned increments between. Full-load rating is 110 amp, 30 minutes, 30 load volts, when used on 220-v, 60-cycle lines. *Westinghouse Elec & Mfg Co, East Pittsburgh, Pa.*

Cable Dead-End

ILLUSTRATION SHOWS Type YE cable dead-end. Thick-walled cable socket is indented on cable end by hydraulically operated portable press. This creates permanently secure grip on conductor. Unit available for all sizes of cable from No. 8 to 2000 MCM. Various types of clevis arrangements can be supplied to meet requirements. *Burndy Engrg Co, 459 East 133 St, New York, N. Y.*

Transmitting System

"NEW-MATIC" SYSTEM MEASURES differences in temperatures, flows, levels, pressures, etc. Consists of two measuring elements equipped with pneumatic transmitters, each of which delivers air pressure proportional to the measured variable, and a differential pressure-detector employing a mercury-filled U-tube, together with a float actuating a recording or indicating pointer. Where differences are large, wide range can be covered, and where differences are small, minute changes can easily be observed. Two transmitters can be as much as 500 ft apart, yet indications will lag only 20 sec for full-scale movement. Actual values of either or both of measured variables may also be recorded on differential pressure-detector chart. *Brown Instrument Co, 4490 Wayne Ave, Philadelphia, Pa.*

Air Hose

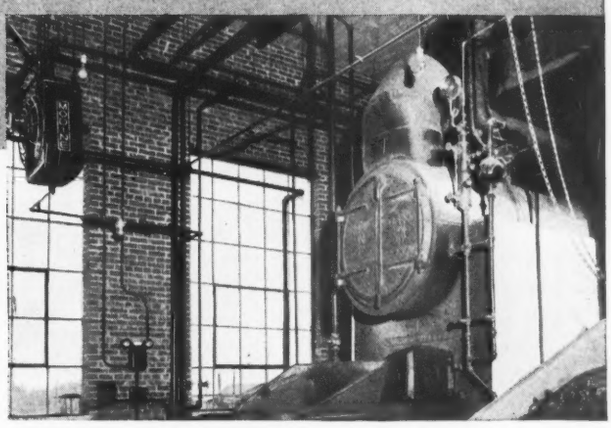
LIGHTWEIGHT AIR HOSE so flexible that ½-in. size can be bent to 3-in. radius without collapsing or cutting off air supply. Compound of tube is oil-resistant rubber, with excellent heat-resisting characteristics. Tube does not flake or clog tools. Yarn reinforcement affords 5-to-1 safety factor. Two braid hose can withstand working pressures from 80 to 125 lb. *B F Goodrich Co, Akron, Ohio.*

Drafting Machine

TRUE LINE DRAFTING MACHINE embodies following instruments used to make drawings: protractor, vernier, T-square, scales and triangles. Equipped with "Quick-Flick"

LIVE STEAM FAILS TO MELT SNOW

Snow-covered steam line at the plant of the Beacon Milling Co., Cayuga, N. Y. The K&M "Featherweight" Insulation was applied by the Mundet Cork Corp., K&M Distributor in New York.



Boiler room in the same plant, showing the K&M "Featherweight" Insulation on the boiler, and the unit heater, at upper left, needed to keep the room warm.

That's the kind of efficiency you get with K & M Insulation

It's easy to show with tables and figures that Keasbey & Mattison "Featherweight" 85% Magnesia is one of the most efficient heat insulators ever developed for temperatures up to 600° F. But when you can actually *see* how well it performs its function—that's a lot more impressive.

The snow-covered line shown above carries live, hissing steam from the boiler room to the process building at the plant of the Beacon Milling Co., Cayuga, N. Y. The steam is used for process purposes in the manufacture of poultry feeds. About 60 feet in length and 20 feet from the ground, the line is exposed to the full sweep of the winter wind across Cayuga Lake. The insulation had to be super-efficient. The illustration shows that it is.

A further proof in this same plant lies in the boiler room itself. K&M "Featherweight" was also used to insulate the boilers. It then became necessary to install a unit heater in the room to keep it warm enough for the operators!

These two examples in one plant are by no means exceptional. Industries the nation over are daily saving heat, fuel and dollars with K&M Insulations. Keasbey & Mattison engineers, working with K&M Distributors strategically located throughout the country, can point the way to real savings in your plant, too. Write Dept. 11 for full details.

KEASBEY & MATTISON

COMPANY, AMBLER, PENNSYLVANIA

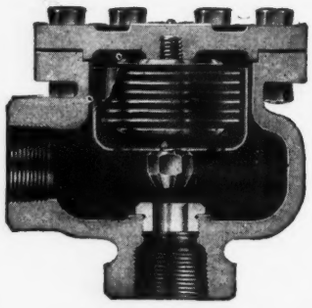
NICHOLSON

CONTROL VALVES FOR LONG, PRESSURE-TIGHT SERVICE

Available in TWO, THREE, FOUR-WAY and Special Types for operating Air, Steam, Water or Oil Cylinders on pressures up to 300 lbs. Made in five different metal combinations to cover all mediums handled. Non-corrosive metals are used in all vital parts. Gaskets and gland packing, suitable for each specific service are used.

Nicholson also offers foot, solenoid and motor operated valves and valves for hydraulic service up to 5000 lbs. pressure. Ask for Bulletin 933 describing "Nicholson" Control Valves.

STURDY STEAM TRAPS WITH EXTRA CAPACITY

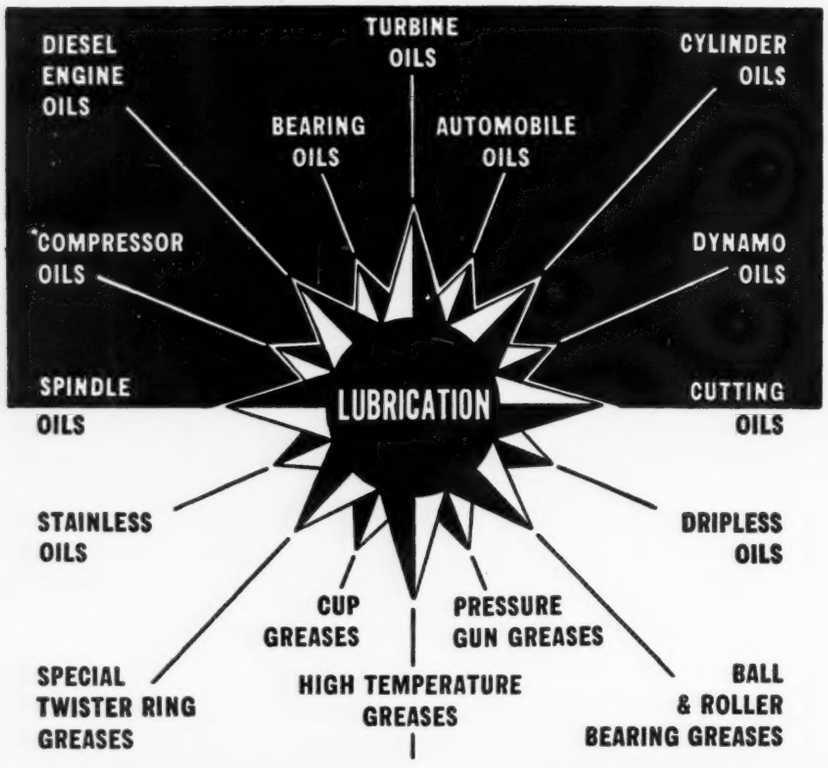


Available in Bronze, Cast Iron and Cast Steel Construction—in sizes from ¼" to 2" and for pressures from vacuum to 300 lbs. with superheat.

Nicholson Industrial Steam Traps are large in capacity, will not freeze, eliminate air binding, require no adjustment, prevent dribbing, provide intermittent discharge and never water-log. In many cases they step up process production from 20 to 30%. Used in leading industrial plants. Ask for Industrial Trap Bulletin No. 439 describing these moderately priced traps.

OTHER NICHOLSON PRODUCTS—NICHOLSON Welded Floats, Piston and Weight Operated Traps, Flexible Couplings, Expanding Mandrels, Arbor Presses, Compression Shaft Couplings, Steam Eliminators and Separators, Compressed Air Traps.

W. H. NICHOLSON & COMPANY
125 OREGON ST. WILKES-BARRE, PENNSYLVANIA, U. S. A.



PRODUCERS of HIGH GRADE LUBRICANTS SINCE 1874

BORNE SCRYMSER COMPANY
17 BATTERY PLACE • NEW YORK

controls, which enable, with flick of thumb, scales to be released for 15-deg automatic stops, or for intermediate stops and locking. Scale can also be set at any angle with protractor and vernier reading zero to zero. Design permits use of instrument with the user's elbow to left or right. Protractor may be used at any angle in complete circle, so that total board-area is made accessible. *Frederick Post Co, Hamlin & Avondale Aves, Chicago, Ill.*

Circuit Interrupter

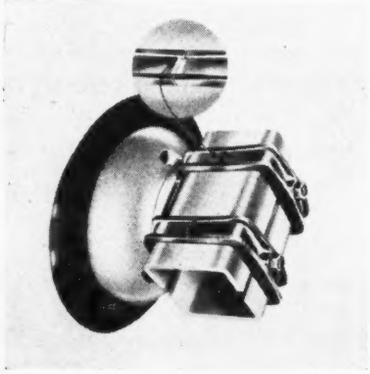
NON-AUTOMATIC ENCLOSED circuit interrupter has high capacity and reduced mounting space. Sheet-steel, dust-resisting unit is designed to replace non-automatic disconnecting devices in industrial plants, central stations, substations, etc. These 2- or 3-pole interrupters have 50- to 600-amp rating on 250 to 600 volts ac and 125/250 and 250 volts, dc. Safety features include cover interlock which prevents closing contacts when cover is open, and opening cover when interrupter is in "on" position. *Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.*

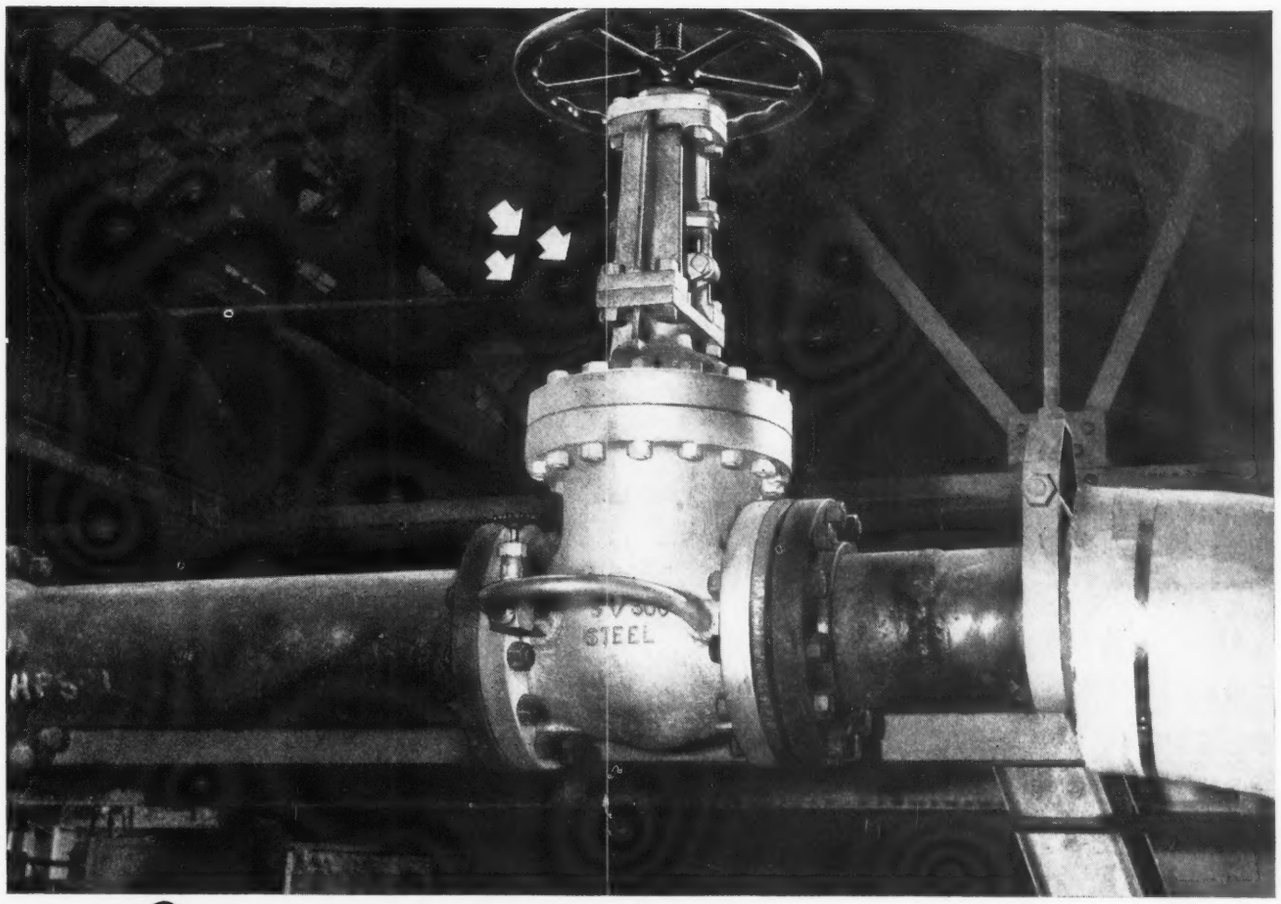
pH Indicator

GLASS-ELECTRODE INDICATOR retains full accuracy, according to maker, up to 85 F in atmospheres of 95% relative humidity. Measurements can be made consistently within its limit of error of adjustment ±0.1 pH. Measurements are made by simply pouring sample into instrument's self-contained beaker, and reading pH directly from meter scale. Shielded instrument embodies rugged deflection meter, and thermionic amplifier of high stability. *Leeds & Northrup Co, 4934 Stenton Ave, Philadelphia, Pa.*

Bus Support Clamp

DEVICE MAY BE USED ALTERNATIVELY as slide fit support or as rigid support by simply clamping caps in desired position. Center clamping studs and guide ridges insure proper spacing of copper channels. Circled inset shows position of clamp when slide fit on conductor is desired. Can be furnished for use on either 3- or 5-in. bolt circle. *Burndy Engrg Co, 459 East 133rd St, New York, N. Y.*





Again—

ENGINEERS DEMANDING UNINTERRUPTED STEAM PLANT PRODUCTION LOOK TO READING-PRATT & CADY FOR THEIR VALVES . . .

★ It became imperative to expand the power plant of a nationally known refiner of metal vital to defense—also to hold maintenance at a minimum to attain peak production.

So engineers imposed as the two top ranking conditions, that valves must be capable of operating continuously for the longest possible periods without need for maintenance, and that valves be designed so that eventual maintenance could be completed in least possible time.

Shown is one of the Reading-Pratt & Cady valves installed to meet those conditions—a 300 lb. Cast Carbon Steel Gate Valve with Stainless trim for service to 750°F. You see it installed in the main steam line between boiler and manifold, handling process steam and steam to the power generating plant.

It may be significant to you that engineers who seek valves for uninterrupted service turn again and again to Reading-Pratt & Cady.

★

READING: CAST STEEL VALVES AND FITTINGS
PRATT & CADY: BRASS AND IRON VALVES
D'ESTE: VALVE AND ENGINEERING SPECIALTIES

READING-PRATT & CADY
READING, PENNSYLVANIA

A Division of AMERICAN CHAIN & CABLE COMPANY, INC.

Full time boiler operation requires a constant check on boiler evaporation to maintain peak efficiency

HENSZEY
BOILER FEED WATER
METERS

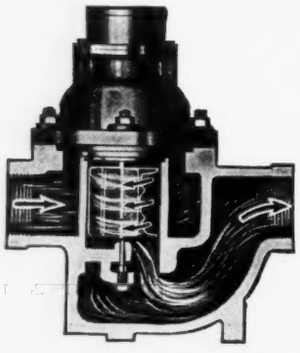
Will MEASURE the FEED WATER and the BLOWDOWN of EACH BOILER!

A Henszey Feed Water Meter measuring the feed water and another measuring the blowdown enables you to figure the amount of evaporation at any time—at a moment's notice.

Henszey Feed Water Meters are equally accurate at high or low flow, on centrifugal, duplex, triplex, or reciprocating pumps, and at all pressures. Their accuracy is not affected by hot, dirty blowdown. Sizes from 10 g.p.m. to 1200 g.p.m. cold water steady flow rating, pipe connections ¾" to 6." Can be calibrated in gallons, pounds or cubic feet at any specified temperature.

Send for complete information

HENSZEY COMPANY
Dept. D8 Watertown, Wis.



Water enters the measuring chamber tangentially, spinning in the chamber as it passes through, forming a vortex. Each gallon that passes through this chamber makes the same number of revolutions of the water. A vane is placed in the rotating water to impart this rotation to the register. No close clearance—less wear—continued accuracy.

HENSZEY
POWER PLANT SPECIALTIES

Reader's Problems

(*Continued from page 109*)

perature. This might be applied in FFM's case.

The baffle must fit tightly enough against the drum to prevent leakage between drum and baffle. Also, openings in the baffle must be equal in area to the gas outlet. This baffle is inexpensive to build as used bricks are usually available.

Greenwood, S. C. E B CHANDLER

Check Soot, Scale

MY EXPERIENCE with tube chokes indicates that they only cut down capacity of a boiler and prevent proper tube cleaning. Much better results can be obtained by careful setting of dampers. At 180% rating, I believe FFM must expect stack temperatures of 600-650 F as most older boilers are designed for 500 F at 100% rating.

Scale and soot are the most usual causes of stack-temperature increase. I suggest FFM inspect the inside of the boilers for scale and, if any is found, give them a thorough cleaning. Good water treatment is very important; boiler water should be tested daily as a guide to treatment and to blowdown. The savings will soon pay for the treatment and for the testing outfit. Tubes should be punched every eight hours or less when operating at 180% rating, either with a good steel brush or a flue-scraper. They may be blown if flue blowers are installed. Carrying less draft, if possible, will also help; no more draft should be used than necessary to produce the needed steam and to prevent smoking. Many times it is possible to use a thinner fuel bed and less draft, securing better CO_2 and better boiler and furnace efficiency.

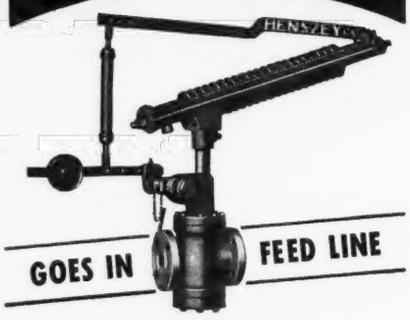
Lombard, Ill. H D BROWN

Blocking Gas Flow Won't Help

IT IS A COMMON ERROR to assume that gas formed by combustion can be held in a boiler by blocking the tubes or other passages. A little thought should make it clear that all gas produced must leave the boiler at the rate of formation and blocking the tubes means only more draft or a reduction in rate of combustion. Thus, the only possibility of reducing flue-gas temperature is to get a greater percentage of heat into the boiler water. This raises the question of the condition of the heat-transfer surfaces.

If tubes and other transfer surfaces are not in first-class condition, they should, of course, be attended to; having done that there is not much more to do if it is necessary to operate at 180% rating. The lower the rating the more heat-transfer surface per lb of steam generated and the lower the flue-gas temperature. I am afraid the trouble is largely inherent in the type of boiler, which is not suited to high ratings. It does not appear that the amount of excess

HENSZEY
BOILER FEED
REGULATORS



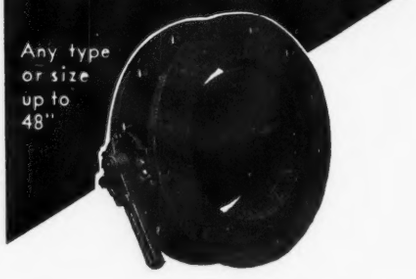
The Henszey Boiler Feed Regulator controls boiler water levels continuously and accurately under *all* load conditions!

These simple, compact, self-contained units go right in the feed line and require no additional structural support. They are as easy to install as a simple gate or globe valve. Once installed and set for operation no further attention is necessary — nothing to get out of order — nothing to reset.

Send for latest Bulletin containing full details.

HENSZEY COMPANY
Dept. D8—Watertown, Wis.

The last word in Blast Gates...

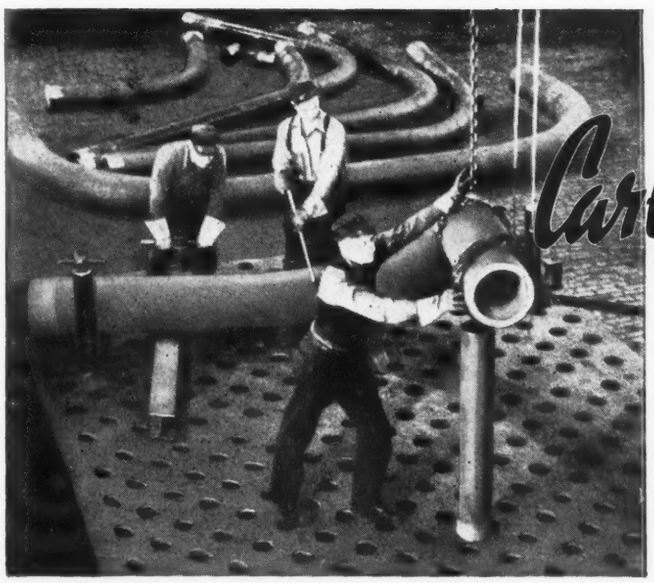


ROCKWELL'S complete line of Blast Gates meets every possible requirement for low pressure air lines. Strong, light, and air-tight, they assure perfect control of air. Superiority has been demonstrated by thousands used throughout Industry.

Ask for Catalog No. 4020

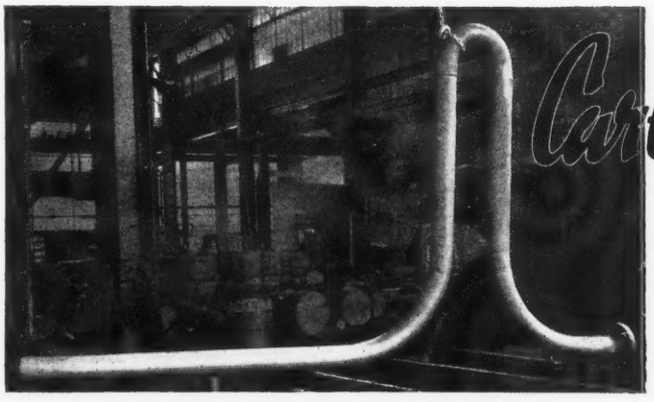
W. S. ROCKWELL COMPANY
Blast Gate Division
50 CHURCH STREET NEW YORK, N. Y.

PITTSBURGH PIPING CAN PRODUCE
Your Piping Requirements to the Letter



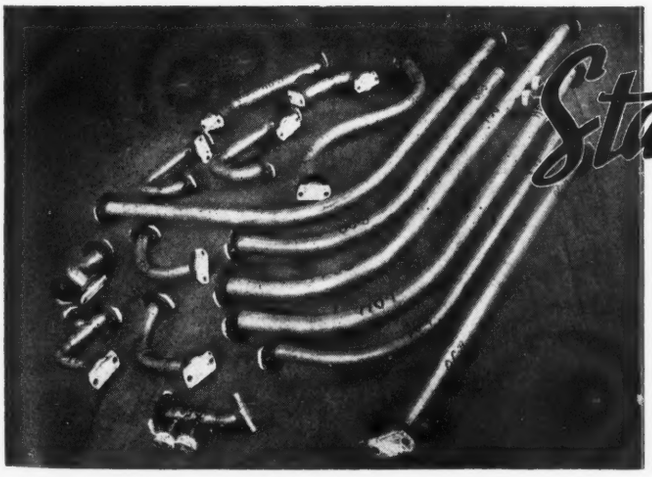
Carbon Moly Steel Piping

Since the increase in steam pressures and temperatures made the use of low alloy steels necessary, Pittsburgh Piping has fabricated and erected this type of piping for many of the country's foremost power systems. Because Carbon Molybdenum and other low alloy steels require extra care in fabrication, Pittsburgh Piping has developed a special technique for the highly efficient working of this type of material. This special technique extends to all operations in field erection as well.



Carbon Steel Piping

In its five acre plant, Pittsburgh Piping has complete facilities for pre-fabricating large sub-assemblies for every conceivable power and process requirement. Modern erection equipment and field welding methods used by specially trained crews assure speedy and efficient erection without interfering with other sub-contractors on the job.



Stainless Steel Piping

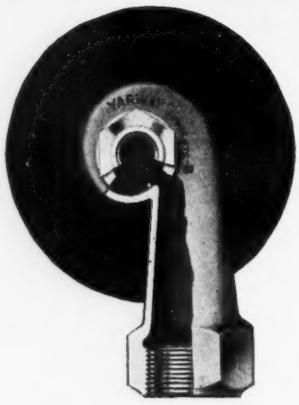
Since 1933, the Alloy Division of Pittsburgh Piping has been fabricating stainless piping and vessels for process industries. Because of the many metallurgical characteristics peculiar to stainless steel alone, Pittsburgh Piping has experienced fabricators that work only on stainless. The relative high cost of raw materials makes it more imperative than ever to have this type of fabrication done by stainless specialists at Pittsburgh Piping.

PITTSBURGH PIPING & EQUIPMENT CO., 10 FORTY-THIRD ST., PITTSBURGH, PA.

Woolworth Bldg. New York | Occidental Bldg. Indianapolis | Peoples Gas Bldg. Chicago | General Motors Bldg Detroit | Public Sq. Bldg. Cleveland | 10 High St. Boston | 1st. Nat'l. Bank Bldg. Charlotte | 525 Market St. San Francisco

Pittsburgh Piping

YARWAY
INVOLUTE
SPRAY
NOZZLES



Unique Yarway Involute design.

No internal parts or vanes to clog or erode.

Unobstructed flow gives minimum loss of head.

Finely divided spray cone provides rapid cooling.

Renewable orifices adapt nozzles for any service.

Installations total more than 5 million gallons per minute in water cooling and air conditioning service.

Made in both cast and bar-stock types. All sizes from 1/4 in. to 2 1/2 in. Write for Catalog N-615.

YARNALL-WARING COMPANY
100 Mermaid Ave. Philadelphia

air is unreasonably large, as this would tend to lower the flue-gas temperature. In fact, high-flue gas temperature indicates not low combustion efficiency, but low heat transfer and this is largely controlled by the amount and condition of the heating surface.

Of course, theoretically, something might be done by installing economizers, which are, in effect, additions to the heating surface, but this probably would not pay, especially if there is enough exhaust steam available to heat feedwater above 200 F. Another possibility is heat exchangers for preheating the air supplied for combustion, but this again entails considerable investment and probably would not pay.

In all probability, the best thing FFM can do is keep his boilers in first-class condition, watch his combustion efficiency and operate as little above rating as circumstances permit. It might even be worthwhile to consider an additional boiler so that the present units can be operated at lower rating.

Bloomfield, N. J. J O G GIBBONS

Change Coal Size

A RULE-OF-THUMB method for estimating flue-gas temperature for small boilers, hand and stoker fired, "375 F plus per cent rating," gives 375 plus 180 or 555 F. I doubt that "tube chokes" or gas restrictors would solve the problem for this reason: they would probably reduce the draft to a point where it would be insufficient for 180% rating.

I suggest FFM consider coarser coal than 1¼-in. nut-and-slack, such as 2-in. nut-and-slack, well sized, with not over 20–30% of ¼-mesh screen material. This coal will produce a more uniformly distributed and porous fuel bed than a 1¼-in. nut-slack with a high percentage of small sizes in it. The coarser fuel also results in less working of the fire, lower carbon in refuse, higher CO_2 and lower flue-gas temperature with attendant increase in efficiency. Larger and more uniform sizing is particularly advantageous for coking coals such as Beckley seam, which swell upon heating, become plastic, and if not levelled and raked form coke "mats" or "islands" and poor fuel distribution.

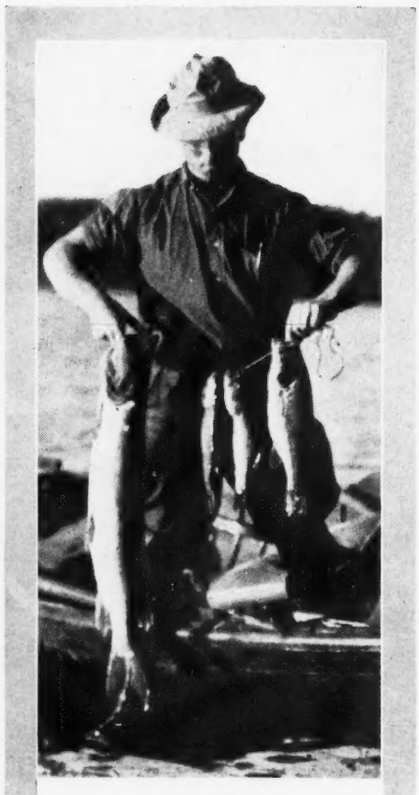
These facts were checked by tests I conducted on a 2350-sq-ft water-tube boiler fired with an overfeed stoker and burning different size coals from the same mine:

Coal size	1¼-in. NS	2-in. NS
Bhp developed	125	130
Flue-gas temp., F	490	430
CO_2 at blr outlet, %	7.8	9.7
Actual evap, lb/lb coal	8.6	9.1
Actual efficiency, %	65.9	69.2
Cost of coal, del'd	$4.58	$4.78
Cost of steam, 1/1000 lb	$.265	$.262

Harmon-on-Hudson, N. Y. R S JULSRUD

Speed Control of Plant Auxiliaries

SPEAKING before the Midwest Power Conference in Chicago, Ill., G. V. Edmonson, American Blower Corp. after discussing the different methods of obtaining variable speed, said that the



Picture of a Plant Man enjoying life . . . . . because his machines are equipped with

AJAX
FLEXIBLE COUPLINGS

Here is how twenty years of specializing on flexible couplings gives you design that keeps the wheels turning—

Rubber bushings and graphite-bronze bearings give positive drive . . . resilient flexible protection against unavoidable misalignment . . . free end float . . . dielectric insulation . . . no noise, no backlash . . . no lubrication worries . . . dependable performance in dust and abrasive-laden air.

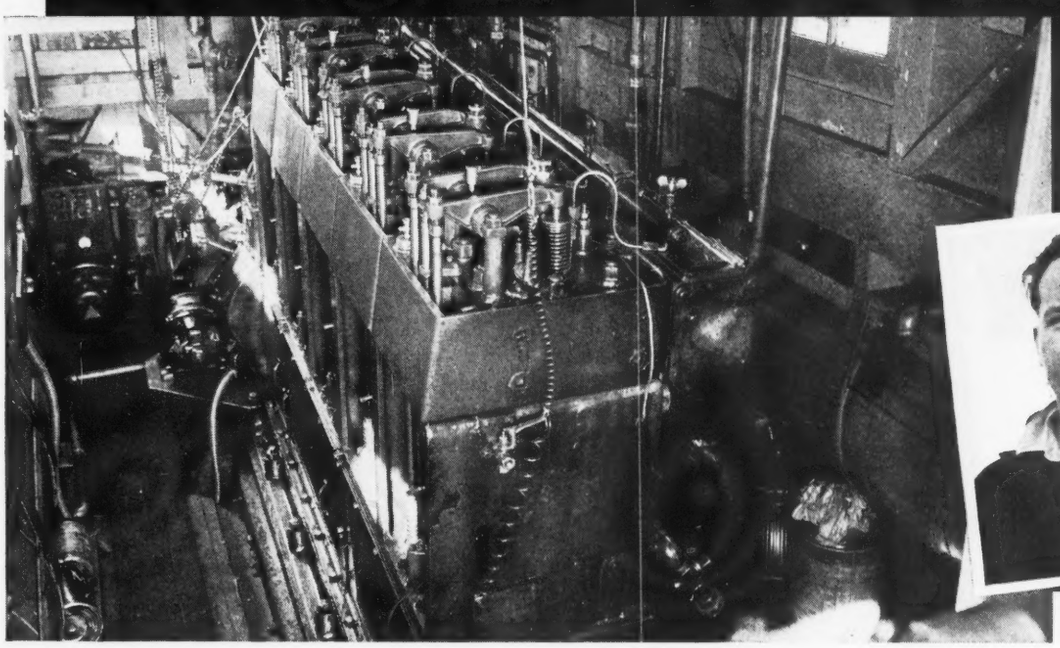
Semi-steel, forged steel, standard and shear pin types in a complete range of sizes. Write for data book.

AJAX FLEXIBLE COUPLING CO.
132 English St. WESTFIELD, N. Y.

BELIEVE IT OR NOT!*— "IN THIS DIESEL . . . MUCH BETTER RESULTS WITH RING-FREE THAN ANY OTHER OIL WE'VE TRIED"

—SAYS C. T. SMITH & SON

TUG BOAT OPERATORS, STEVENSON, WASH.



At left: The 215 h.p. 5-cylinder, National Superior Diesel of the tug M. S. Warco

Below: ESSON H. SMITH

Says Esson H. Smith, "With other oils we often had trouble with pistons and valves. After a complete overhaul, installing new rings, sleeves, main bearings and connecting rod bearings we used Ring-Free SAE 40. After 3500 to 4000 hours, a general check-up showed: wear, fore and aft at top, only .002; we could detect no wear at bottom of each cylinder nor was wear, port and starboard, in any case over .0015. The main bearings were in perfect shape." Mr. Smith then tacks on this P.S., "The diesels in our tugs 'Charles T' and 'Sakana' are using Ring-Free with equal success." Ring-Free has a powerful story to tell ANY diesel operator. Want to see it? Call the Macmillan Man . . . or write direct.

MACMILLAN PETROLEUM CORPORATION

50 WEST 50TH STREET, NEW YORK • 624 SOUTH MICHIGAN AVENUE, CHICAGO • 530 WEST 6TH STREET, LOS ANGELES

Believe It or Not! by Ripley
REG. U. S. PAT. OFF.
RING-FREE IS NOT JUST A ONE-TIME MOTOR-TONIC-IT'S A PURE OIL THAT CLEANS YOUR MOTOR CONSTANTLY - AS IT LUBRICATES!
HOW RING-FREE REMOVES CARBON AND TURNS THE OIL BLACK
DIRTY HANDS
CLEAN WATER
SOAP
CLEAN HANDS
BLACK WATER
DIRTY MOTOR
RING-FREE
CLEANER MOTOR
BLACK OIL
—as drawn by Ripley in Life, Collier's, Time

MACMILLAN RING-FREE MOTOR OIL

*Reg. U. S. Patent Office

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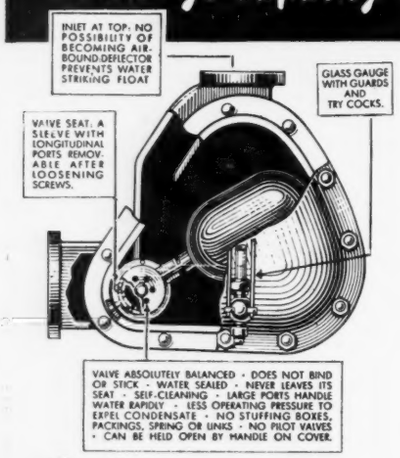
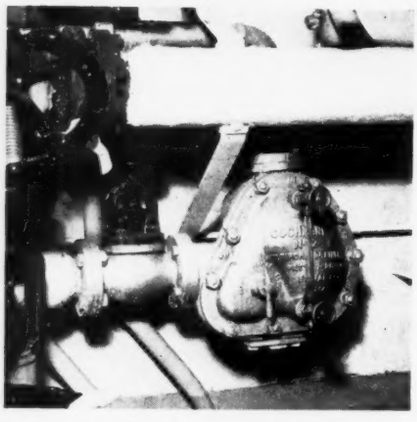
Extraordinary Discharge Capacity


INLET AT TOP: NO POSSIBILITY OF BECOMING AIR-BOUND. DEFLECTOR PREVENTS WATER STRIKING FLOAT
GLASS GAUGE WITH GUARDS AND TRY COCKS.
VALVE SEAT: A SLEEVE WITH LONGITUDINAL PORTS REMOVABLE AFTER LOOSENING SCREWS.
VALVE ABSOLUTELY BALANCED · DOES NOT BIND OR STICK · WATER SEALED · NEVER LEAVES ITS SEAT · SELF-CLEANING · LARGE PORTS HANDLE WATER RAPIDLY · LESS OPERATING PRESSURE TO EXPEL CONDENSATE · NO STUFFING BOXES, PACKINGS, SPRING OR LINKS · NO PILOT VALVES · CAN BE HELD OPEN BY HANDLE ON COVER.

Cochrane

MULTIPORT DRAINER

for *Quick* Drainage of *Large Quantities* of Condensate . . .



THE "Multiport" principle on which the Cochrane Drainer operates is that of a hollow cylindrical valve with a number of longitudinal ports which register with similar ports in the valve seat when the float is in the raised position. The combined capacities of these ports is unusually large, which accounts for the valve's extraordinary discharge capacity. For complete details mail this coupon.

COCHRANE

Cochrane Corp., 3106 N. 17th St., Phila., Pa.
Please send me copies of your publications on Condensate Drainage

Name.....

Firm.....

Address.....

City..... .....State.....

principal reason for using variable-speed drives for power-plant auxiliaries is economy. This includes power saving, reduced maintenance and accurate regulation for best plant operation.

Sound-engineering practices require that certain and often quite liberal, factors of safety be used in the calculations and specifications of auxiliaries, so that it is often found that an auxiliary must deliver its rated capacity at lower than specified pressures. This condition requires that the control reduce the speed of the auxiliary. Whereas control by dampers or valves requires the driving motor to operate at constant-speed horsepower, variable speed needs less input horsepower.

Reduced Maintenance

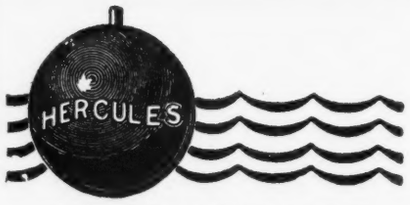
Variable-speed control also reduces maintenance on auxiliaries. Whether it be a fan, boiler-feed pump, or cooling-water pump, best operation occurs when fluid from the impeller flows from the casing with minimum restriction. Since the capacity of a unit varies as the impeller speed is reduced, it is possible to obtain capacity control by variable speed without restriction of flow, a condition favorable for minimum wear.

At reduced capacity where auxiliaries are controlled by variable speed, there is less tendency for high-pitch noises and vibrations. Variable-speed adds an additional life factor for the unit bearings, as wear is necessarily reduced at lower operating speeds. Accurate regulation of all auxiliaries to insure best plant operation is a third item in securing economy.

Simplicity of control is essential. Capacity adjustment of an auxiliary must be accomplished with a minimum amount of effort and time on the part of the plant operator in order that he may be available for more essential duties. The variable-speed unit must be adaptable to existing simple and well-established methods of control equipment. It should be capable of a uniform degree of response over a wide capacity range and follow the demands of the plant operator or the automatic control. Then, the system responds uniformly, thereby eliminating conditions of excess or too little capacity from one auxiliary as compared to what another may be doing.

Automatic control functioning with variable speed is more attractive in that, without introducing the human element, changes of load are accomplished without upsetting plant balance. The operator's function becomes one of periodic checking of

HERCULES
Seamless Copper
FLOATS



GUARANTEED TO STAND UP!

Every Hercules Float carries our guarantee to stand up under 350 lbs. working pressure and 500 degrees temperature.

Fabricated of seamless copper under our special spinning process. Hercules Floats are uniform in thickness and high in mechanical strength.

You can depend on Hercules for floats—in standard shapes up to 10 in. and in special types to your specifications—to give long, dependable, economical service.

Insure care-free maintenance of water level in your heaters, tanks, reservoirs and other equipment by specifying "HERCULES."

HERCULES FLOAT WORKS
200 Franklin St.
SPRINGFIELD, MASS.

Precision-Built by Master-Craftsmen

MODEL GPV

Pressure and Vacuum Gauge — Compound — Pressure side of this gauge generally is graduated to 15 lbs., 30 lbs., or 60 lbs., but it can be scaled to any pressure not exceeding 500 pounds.

Full information on this gauge and other products in complete catalog, free on request to J. E. LONERGAN CO., Race and Second Sts., Philadelphia, Pa.

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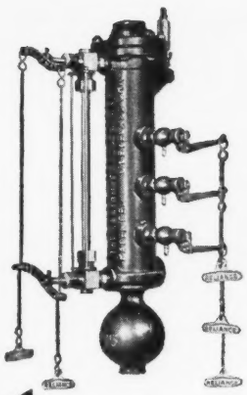
SPECIALTIES
VALVES
Gauges

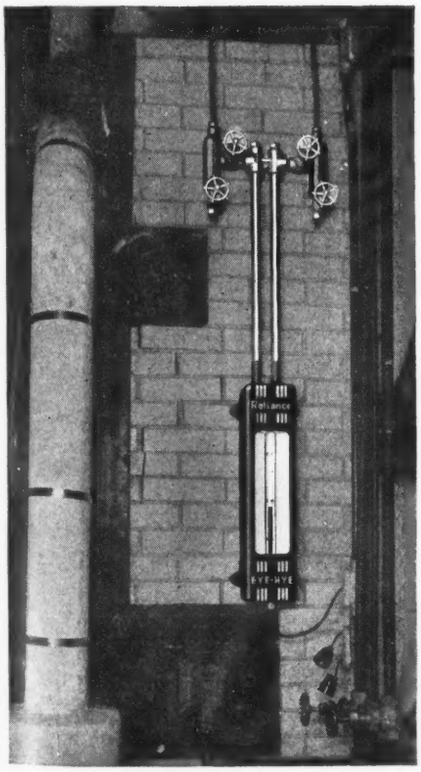
300 Specialties for Power Plants-Since 1872



You wouldn't risk power failure NOW *at any cost!...*

Prevent boiler outage and expensive accidents with the *"double check"* water level supervision

RELIANCE SAFETY TEAM
SOUND CHECK ALARM Water Column
SIGHT CHECK EYE-HYE Remote Gage



EYE-HYE hooks up easily, can be located where most convenient. Practically no upkeep or expense.

NO SHORTAGE of *material* these days is any more serious than a shortage or break in your *power supply.* The Reliance Safety Team—ALARM and EYE-HYE—helps you maintain safe, efficient boiler water levels; gives you facilities for supervision that prevents time-and-money-wasting power breaks.

The convenience of this double protection is shown by the installation at Union Starch and Refining Co., Granite City, Ill. *Above* you see the Reliance ALARM, sensitive SOUND check that signals operators if water reaches dangerous stages. Usually preventing the need for that warning, however, is the EYE-HYE down at eye level on the boiler room wall—accurate, sharp and clear SIGHT check, seen at a glance; insures *frequent* reading.

The hundreds of plants equipped with the Reliance Safety Team are admirably set up to maintain vitally important safe continuous operation. Write for EYE-HYE Bulletin 382, and ALARM information if you aren't equipped with Reliance Boiler Alarms.

THE RELIANCE GAUGE COLUMN CO., 5902 Carnegie Ave., Cleveland, Ohio

BOILER SAFETY DEVICES since 1884

Reliance

MAXIM
SILENCERS

ARE GOOD NEIGHBORS

It is good public relations for any company to minimize operating noises that might disturb the surrounding community.

Among the worst offenders against quiet operation are the exhaust or intake noises and pulsations from internal combustion engines . . . and these can be effectively eliminated with Maxim Silencers. If you have been confronted with this "noise nuisance" problem, consult MAXIM . . . SILENCING SPECIALISTS FOR TWENTY-FIVE YEARS.

SEND THIS COUPON FOR DETAILS

THE MAXIM SILENCER COMPANY
92 Homestead Ave., Hartford, Conn.
Please send details on your ☐ Engine Exhaust or Intake ☐ Steam ☐ Compressor Silencers.
Name .....
Company .....
Address .....
City ..... *State* .....

results and a normal amount of maintenance work to keep his control equipment in best working order.

It is not uncommon for the capacity of a fan to be varied infinitely over 80% of its speed range. This varying demand of a fan requires that the variable-speed unit be capable of an 80% maximum reduction of speed and that it take a minimum of power to handle this low load. The hydraulic coupling can produce these results. On the other hand, 15% to 18% speed reduction is sufficient to reduce the capacity of a boiler-feed pump to a minimum. This requires that a variable-speed unit must afford not only infinite increments of speed adjustment, but also possibilities of accurate control. The hydraulic coupling is likewise being used successfully on many pump installations, both large and small.

Selection of a variable-speed coupling should be based on the maximum designed horsepower required and transmitted at a loss in speed from motor to driven shaft of approximately 3%. The fluid used in the hydraulic coupling is a light mineral oil having a 150-SSU viscosity at 100 F. This fluid is used because of its lubricating qualities, availability and relatively low cost.

At the maximum speed of 97% a loss in speed of 3% exists. This per cent drop in speed is a direct indication of the efficiency of the coupling. To this loss in efficiency must be added a windage and pumping loss of the order of 1%.

Hydraulic Coupling

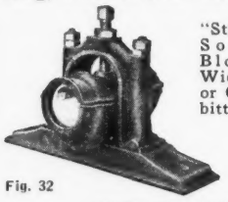
Since the hydraulic coupling consists of only two rotating members, the torque output for all conditions of speed and filling is equal to the torque input and it follows that the efficiency is approximately the per cent output speed. Therefore, the efficiency at 75% speed is 75% and at 50% speed is 50%. From this efficiency must be subtracted the pumping and windage loss. Since torque requirement of a fan varies as a square of the speed, the power input to a hydraulic coupling being driven by a constant-speed motor varies likewise so the power loss is not a major item.

Torque requirements of a constant-head boiler-feed pump vary as a third to fourth power of the speed and the power input to the hydraulic coupling varies likewise. In addition, speed range to accomplish complete capacity regulation of the boiler-feed pump is narrow, consequently, the efficiency is

"STANDCO" PILLOW BLOCKS

Fig. 1635

Combining clamp block and pillow block requirements in one type, the "Standco" shown above is sturdily built and is offered in a wide range of sizes. Babbitted bearing surfaces are finished beautifully smooth, both faces machined. It can be depended on for long, trouble-free service.



"Standco" Ball and Socket Pillow Block. Ring or Wick Oiling, Plain or Collar End Babbitted Bearings.

Fig. 32

Write for Bulletin

STANDARD PRESSED STEEL CO.
JENKINTOWN, PENNA.
Boston, Detroit, Indianapolis — Box 577 — Chicago, St. Louis, San Francisco

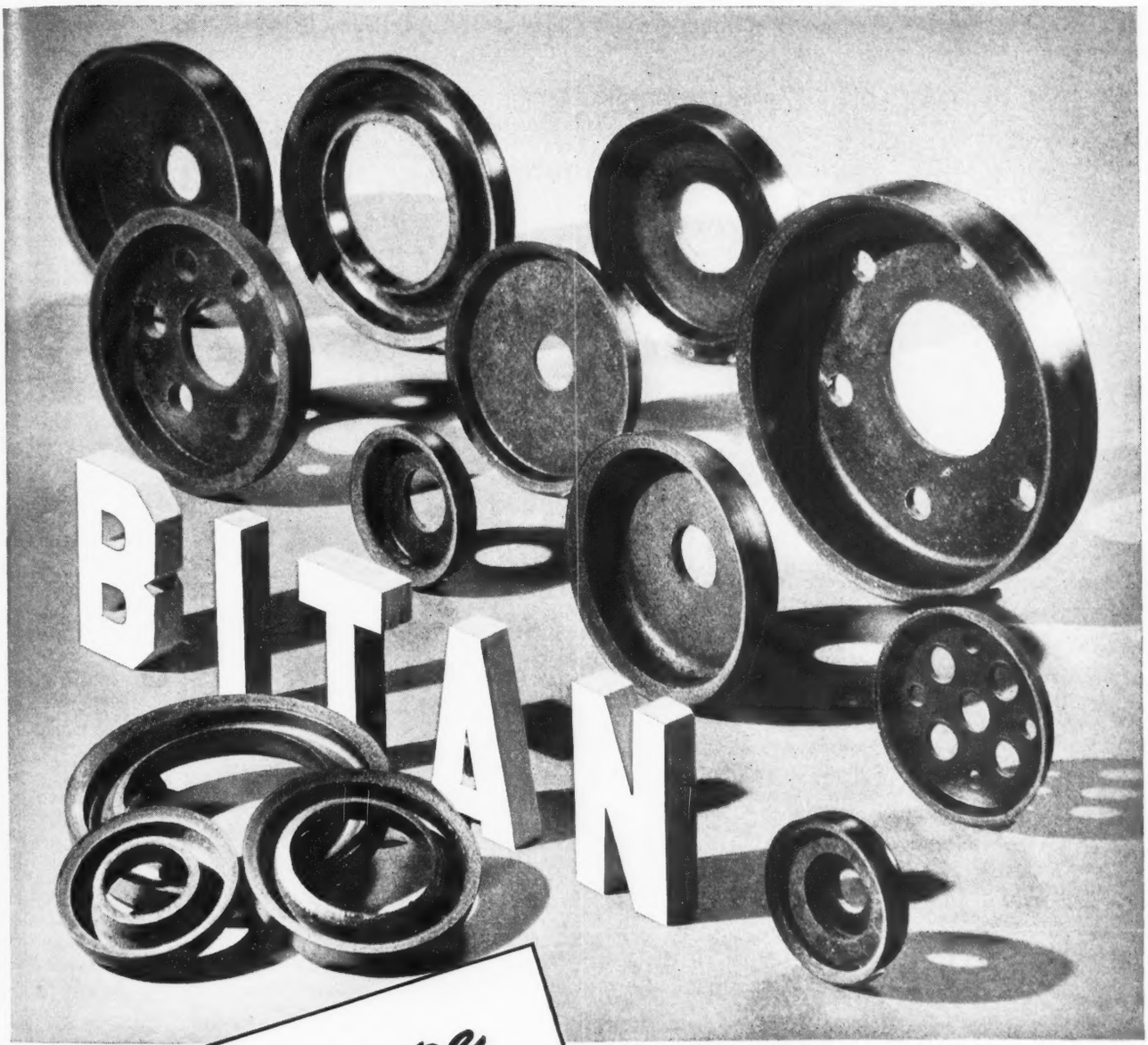
ECLIPSE SEAMLESS FLEXIBLE METAL HOSE

Normal Pitch

Close Pitch

Of seamless, all metal, parallel corrugated, armored construction, in various alloys with renewable type fittings approved for the conveyance of non-solids and non-abrasives in *Aviation, Automotive, Marine, Heating, Air Conditioning, Mining, Power Generation, Plastic and Textile applications* wherein conditions of flexing and expansion between delivering and receiving connections exist. Also available for shielding and exhaust applications.

METAL HOSE DEPARTMENT
ECLIPSE AVIATION, BENDIX, N. J.
DIVISION OF BENDIX AVIATION CORPORATION



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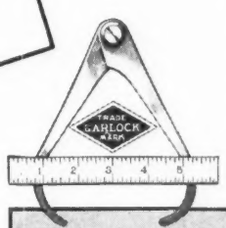
Garlock Leather Packings are manufactured in all types or forms for which leather commonly is used: Molded Cups, "U" and "V" Packings, Flange or Hat Packings, Washers, Gaskets and Discs. GARLOCK BITAN as well as GARLOCK Oak and Chrome Packings in all of these forms are produced in all commercially practicable sizes and for every service condition for which leather packings are suitable.



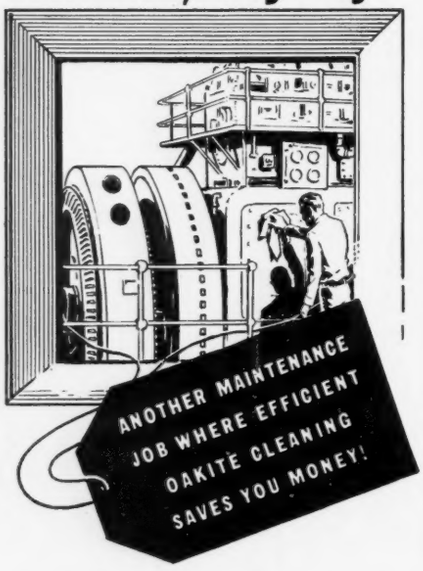
Carefully selected raw leather, special tanning and proper treating give GARLOCK BITAN Leather Packings high tensile strength to withstand heavy pressures and make them resistant to temperature and acid or alkaline solutions. Proper tannage and treatment to suit the particular service are used in filling each order. Write for descriptive folder.

THE GARLOCK PACKING COMPANY
PALMYRA, N. Y.

In Canada: The Garlock Packing Co. of Canada Ltd., Montreal, Que.

GARLOCK
Bitan
LEATHER PACKINGS

Are You Cleaning Painted Equipment This Safe, Easy Way?



To keep painted generators, turbines and other operating equipment clean, bright, new-looking, more and more plants do it the safe, easy Oakite way . . . with effective, low-cost OAKITE RENOVATOR.

A quick wipe-down with recommended solution removes oil, grease, smudge and finger-marks without harming painted surfaces in the least. Users say this remarkable material is the SAFEST, easiest and most economical to apply they have ever used!

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HELPFUL BOOKLETS FREE!

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OAKITE *Certified cleaning*
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

high and the losses are low. This power loss at reduced speed must be carried away in the form of heat.

Large relatively low-speed couplings have sufficient radiating surface to keep them cool. On high-powered units for modern plants, additional oil-cooling surface must be provided. To do this part of the fluid is removed from the coupling and passed through an external cooler.

Rapid strides have been made in the development of power-plant primary units with a resultant rise in efficiency. In this there has been added interest shown in efficient variable-speed apparatus for the increasing sizes of power-plant auxiliaries. Increased economy can be obtained by the application of variable speed drives and their import ance will increase as higher economies are demanded.

Outdoor Boiler for Taunton Power Plant

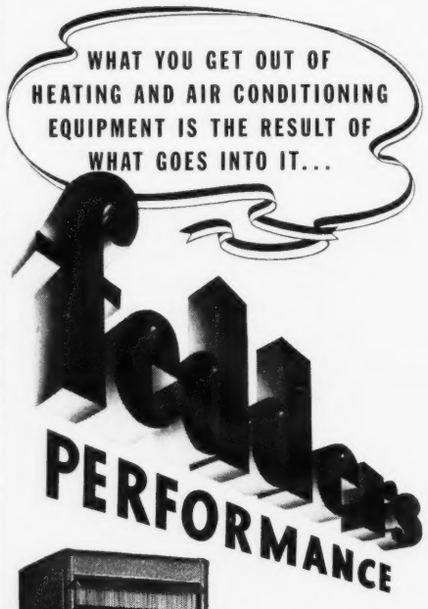
In connection with addition of a 5000-kw, 850-lb, 900-F Westinghouse topping steam turbine to its West Water St station about Jan 1, 1942, the Taunton, Mass., municipal lighting department has ordered a 212,000-lb-per-hr outdoor Riley boiler, to be ready for service at the close of this year. Back-pressure steam will be utilized by existing turbine equipment at 200 lbs.

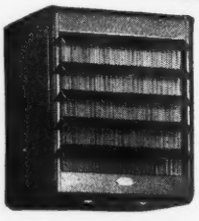
Auxiliary equipment recently ordered includes Worthington boiler-feed pumps, Bailey combustion control, Permutit deaerating heater, Underground high-pressure piping, Lunkenheimer and Edwards valves. Arthur L Nelson, Boston, Mass., are consulting engineers for the plant.

More Funds for Coulee

Initial funds for the second three 108,000-kw generators at Grand Coulee dam have been added to Interior Dept's appropriation bill. Bids will be asked for the units soon, with delivery to be made as early as possible, so that the energy will be available sometime late in 1942 or early 1943. The amount provided by the Senate was $3,000,000.

It is probable that additional funds will be sought from Congress shortly for at least the third set of units for the power house now finished, and very likely, in addition, for some or all of the nine units for the other power house at the dam, in order to bring it to its ultimate capacity within three or four years.





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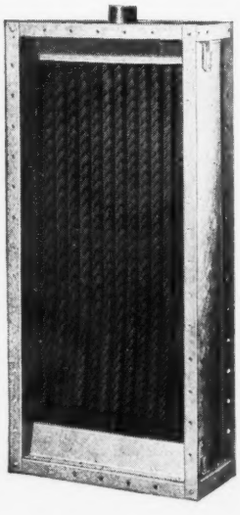
Series 4
UNIT HEATERS

The performance record of Fedders Unit Heaters, Heating and Cooling Coils, and other associated products is the result of their field-proven engineering. What you get out of heating and air-conditioning equipment is the result of what goes into it. Modern design and highest quality materials include strong, rigid casings . . . full floating protection against overall expansion between individual tubes . . . permanently bonded fins and tubes . . . large plenum type headers.

Fedders equipment is built in a complete range of well graduated sizes. Progressive manufacturing methods assure prompt deliveries under today's conditions. Write for Catalogs.



FEDDERS
Type K
HEATING COILS

FEDDERS
MANUFACTURING CO., INC.
Air Conditioning Division
63 Tonawanda St., Buffalo, N. Y.
Representatives in All Principal Cities.

BOILERS *can Loaf, too*

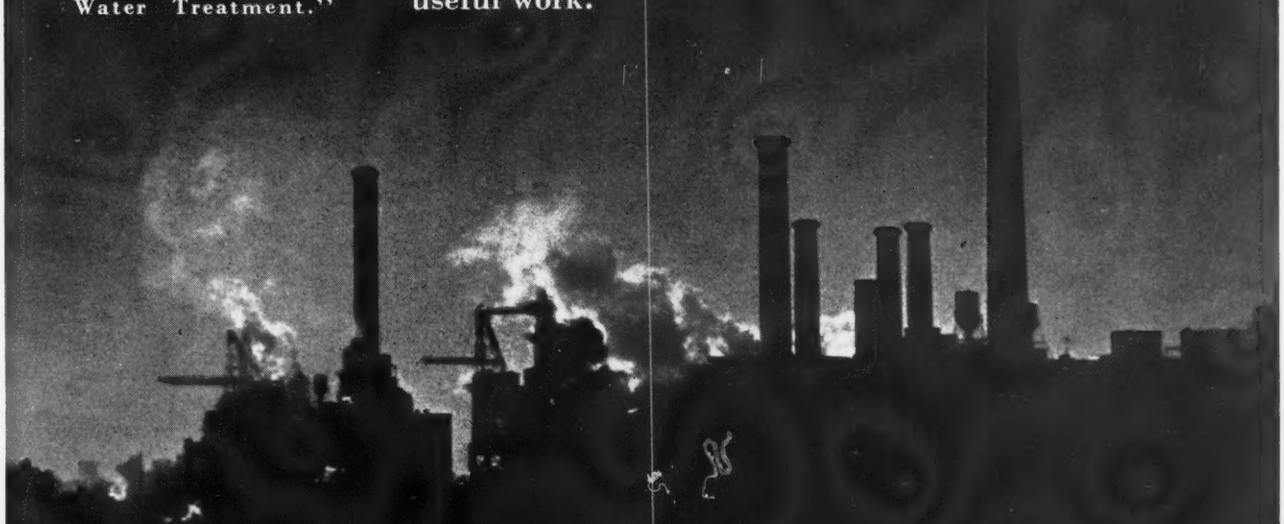
A steam boiler, like a man, has a greater capacity for work than is usually derived from it. Similarly, its value rises with any new output gained.

A boiler's work is to burn fuel and circulate water, turning as much as possible of the heat of the fuel into steam. This work is slowed down proportionately as the boiler collects scale.

There are many ways to raise the efficiency of a boiler; the best is to stop any scale before it even starts to form.

That is Bird-Archer's way . . . scientific treatment of the boiler water . . . through which thousands of companies now get far greater value from their boiler investment in terms of useful work.

Have you a copy of this useful handbook on types of water, situations, treatments? We'll be glad to send you one—without cost, of course. Simply write for "Boiler Water Treatment."



THE BIRD-ARCHER CO.

Scientific Boiler Water Treatments
SINCE 1885

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Chemical Feeders
and
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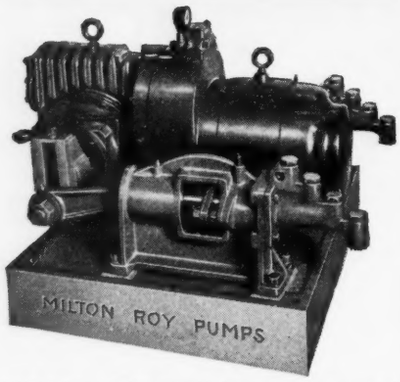


HIGH PRESSURE PUMP
with Accurate Control of Capacity

If you need more accurate control of volume in pumping boiler-treating solutions use a Milton Roy Pump with new screw adjustment for varying piston stroke from zero to 100% capacity.

A Duplex pump of this type will pump against any boiler pressure, right up to the critical 3226 lbs. at 706.1° F. temperature.

The pump shown has 3 gallons per minute capacity against 1350 lbs. per sq. in. pressure. Valve chambers are cast steel. Ball-checks, valve-seats and pistons are stainless. Ball-checks are readily accessible. Stroke of each unit is individually adjustable. Angle gear drive using double reduction gearing affords maximum efficiency in use of power for high pressure service.

Milton Roy Pumps are built in single-end, double-end and duplex types. Capacities from one to 1200 g.p.h. In all metals that can be cast or machined, also transparent plastics. To handle chemicals such as

• SODIUM SULFITE • SODIUM PHOSPHATES
• CALGON • SODA ASH • CAUSTIC SODA • LIME
• ORGANIC BOILER WATER TREATMENTS

State your requirements for recommendations . . . ask for catalog . . . also Proportional Feed Diagrams.

MILTON ROY PUMPS
1362 E. Mermaid Ave., Chestnut Hill, Phila., Pa.

New Bulletins

BOILERS AND ACCESSORIES

1 BOILERS—Erie City Iron Works, Erie, Pa. 8-page booklet illustrates and describes Erie City V-L boilers, presenting construction, dimensions and applications.

2 STOKER — Combustion Engineering Co, 200 Madison Ave, New York, N. Y. Catalog No. SS-2 describes latest design features of C-E spreader stoker, including photographic illustrations of assemblies and typical installations, and close-up views of feeder, distributor, drive mechanism and dump-grate details.

3 SPONTANEOUS-COMBUSTION INDICATOR—Coal Specialties Co, 50 Church St, New York, N. Y. 2-page leaflet describes "Hot Spot Indicators" for indication of excess temperatures in coal piles. Explains spontaneous combustion and shows how it can be overcome.

4 COAL CRUSHER — McNally-Pittsburgh Mfg Co, 307 N Michigan Ave, Chicago, Ill. Bulletin No. 740 shows coal crusher and gives test charts with results of operation in crushing various types of coal.

5 GRATES—The McClave Co, Mill St, Allentown, Pa. 16-page booklet illustrates and describes all McClave products associated with hand-firing of solid fuels. Covers sectional-expansion boiler fronts, dead plates, ash clean-out doors, sidewall doors, and side wall observation doors.

ELECTRICAL EQUIPMENT

6 TRANSFORMERS — Allis-Chalmers Mfg Co, Milwaukee, Wis. 16-page bulletin No. B-6152 covers transformers for secondary ac network systems, including outline sketches, installation and shop assembly views, and construction details of standard and special-network transformers.

7 ELECTRIC EQUIPMENT—Howard B Jones, 2300 Wabansia Ave, Chicago, Ill. 20-page catalog No. 11 illustrates and describes complete line of multi-contact plugs and sockets, terminals, terminal panels, fuse-mounts, etc.

8 SWITCHES—Schweitzer & Conrad, Inc, 4435 Ravenswood Ave, Chicago, Ill. Bulletin 210 describes disconnect switches for distribution systems. Types ES, ESL switches covered, with illustrations used to present construction features.

9 SWITCHGEAR — Allis-Chalmers Mfg Co, Milwaukee, Wis. Bulletin B-6012A covers metalclad, vertical-lift switchgear. Covers special construction features and advantages of company line; includes installation views, dimensions, outline drawings and circuit diagrams.

10 MEGOHMER—Herman H Sticht Co, 27 Park Pl, New York, N. Y. Bulletin No. 430 describes new Model B-5 Megohmer. Covers detailed explanation of instrument, ease of operation, ease of maintenance, and applications in the field.

HEATING, VENTILATING & AIR CONDITIONING

11 BLOWERS — Roots - Connersville Blower Corp, Connersville, Ind. 6-page folder covers applications of Victor-Acme blowers and gas pumps for use with oil- and gas-fired units. Contains comparative curve plate showing advantages of rotary positive type, etc.

12 AIR CONDITIONING—Carbondale Div, Worthington Pump & Machinery Corp, Harrison, N. J. 28-page bulletin describes Carbondale equipment for buildings and institutions. Covered are air-conditioning units, refrigeration compressors, refrigeration condensers, deaerators, feedwater heaters, liquid meters, pumps, refrigeratng units, room coolers, hot process water softeners, etc.

revises work tolerances

• The anti-friction bearing on this roll grinder demands adjustment to exact tolerance. "Without the Laminum shim," the manufacturer explains, "it would be necessary to turn down the cast iron collar a precise amount." He merely peels off Laminum brass laminations! Shims cut to your order. Obtain stock shim materials for maintenance work from mill supply distributors.

Laminated Shim Company INCORPORATED
61 Union St., Glenbrook, Ct.

Write for file-folder of shim application photos, and Laminum sample.

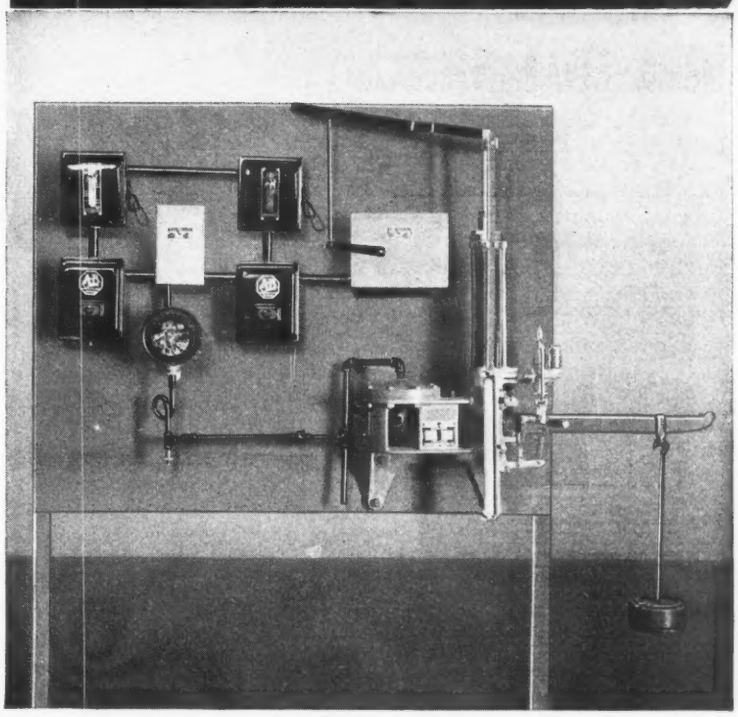
1664

LAMINUM
THE SOLID SHIM THAT peels FOR ADJUSTMENT

INSTANT RESPONSE ...

to VARIABLE LOADS with CANTON Synchronized Stoker Control

- Sensitive to fractional changes in Steam Pressure.
- Automatically adjusts firing rate from 50% to 200% of Boiler rating within a few seconds.
- Steps up efficiency and lowers operating cost.
- Jerk-free operation.
- Reduces manual attention.
- Replaces hit-and-miss operation with scientific fuel and Combustion Control.
- Available in (Hydra-matic) (oil or water), Aero-matic, and Electro-matic Types.
- One Control System serves one or a half dozen Boilers—simplifying installation and lowering cost.
- No special motors required—no Slip Rings; no double shafts;—select any standard stock motor.



(Above) Shown is a typical Panel Board showing simple and effective arrangement of a typical Hydra-Matic Synchronized Control System.

CANTON STOKER

THE ONLY STOKER WITH THE 5 YEAR GUARANTEE

For a fraction of the former cost, you can now have complete Combustion Control for your small and large boilers, resulting in substantial EXTRA Savings in Fuel and operating costs.

Plan to get maximum returns from your investment in Stoker equipment. Write TODAY for Descriptive Bulletin No. 600.

CANTON STOKER CORPORATION
ANDREW PLACE, S. W., CANTON, OHIO

WANT TO PREVENT "ALL-OUT" CIRCUITS?

"All-Out" is a mighty good defense phrase, but it's a terrible headache when it applies to wiring circuits. And right now the continous use of production circuits is setting the stage for scenes like this in hundreds of plants. When the load builds up *and stays up*, copper heating dries out ordinary insulation and vibration opens up cracks that are bound to make trouble . . . unless the danger is averted *in advance* through the use of Rockbestos permanently insulated wire and cable.

1. Rockbestos A.V.C. Boiler Room and Lighting Wire
2. Rockbestos A.V.C. Power Cable
3. Rockbestos All-Asbestos Power and Rheostat Cable

Numbers 1 and 2, Underwriters' and N.E. Code–Type AVA–max. operating temperature 230°F., number 3, Type AI, max. operating temperature 257°F.

Another thing to remember is that expanding production is likely to require new feeders and branches to new plant areas, some of them of necessity too close to steam-lines, drying ovens, boilers, furnaces, etc. If this happens in your plant remember previous wire failures and insist upon installing a wire that won't interfere with production by failing in the pinches. And, remember, too, that Rockbestos wires give you fire protection because they won't burn or carry flame.

For almost a quarter of a century Rockbestos has made nothing but wires, cables and cords for severe service. During that time a lot of "know how" has been acquired in turning out ***permanently insulated*** wire that is resistant to heat and moisture, alkalies, caustics, fire, oil and grease. Hundreds of constructions have been developed to meet unusual requirements. This experience is yours for the asking. Just tell us what is bothering you and your wire and we'll try to lick it. Rockbestos Products Corporation. 811 Nicoll Street, New Haven, Conn.

ANTICIPATE YOUR REQUIREMENTS!

Also refer to McGraw-Hill Electrical Buyers Reference

New York Pittsburgh Buffalo St. Louis Cleveland Los Angeles Detroit San Francisco Chicago Seattle Portland, Ore.

ROCKBESTOS A.V.C.–*the wire with permanent insulation*

Rockbestos A.V.C. Motor Lead and Apparatus Cable–Underwriters' and Nat. Electrical Code Type AVA –one of 118 different permanently insulated wires.

pillar Diesel owners. Brief statements concerning operating results are included, together with photos of plant owners and engines.

PUMPS

43 PUMPS — Pacific Pump Works, Huntington Park, Calif. Bulletin No. 78 describes Pacific single-stage process centrifugal pumps, Type "SV". In addition to complete description, booklet has pictures showing component part assemblies, as well as installation views.

44 PUMPS — Allis-Chalmers Mfg Co, Milwaukee, Wis. 40-page bulletin No. B-6146 describes and illustrates single-stage double-suction centrifugal pumps. Besides construction features, dimensions and application data, bulletin includes friction tables, head-capacity tables and other pump information.

45 PUMPS — Worthington Pump & Machinery Corp, Harrison, N. J. Bulletin, W-412-B30 describes and illustrates horizontal duplex-plunger power pumps, types KLF, KKF and KMF. Drawings and photos show system of lubrication, bearings, pistons, etc.

WATER TREATMENT

46 CHEMICAL PROPORTIONER — Cochrane Corp, 17th St & Allegheny Ave, Philadelphia, Pa. Publication 3015 covers details of proportioner design, construction and application, with flow diagrams, of Cochrane flow meters to typical water-conditioning-control applications.

47 WATER TREATMENT — Water Treatment Co of America, 1159 Hodgkiss St, Pittsburgh, Pa. 8-page technical bulletin describes supplementary boiler-water-treatment service for soda ash and lime and Zeolite water coagulants, known as Baerite-16. Manufacturer claims compound will remove all scale, rust, and corrosion from boilers in about one-fourth time required by other methods.

48 WATER TREATMENT — Water Service Laboratories, Inc, 423 West 126th St, New York, N. Y. Bulletin entitled, "What to Do About Water-Pipe Corrosion" describes causes of pipe corrosion and the effect of corrosive waters on iron and brass piping. How to overcome and prevent resultant nuisances such as rusty water, diminished flow, leaks and breaks also discussed.

49 WATER TREATMENT — D W Haering & Co, Inc, 2308 S Winchester Ave, Chicago, Ill. Reprint of article "Study of Water Problems in Atmospheric Cooling Systems", discusses the fundamental principles involved. Illustrations and complete description of six laboratory cooling systems used for research are presented.

50 WATER TREATMENT — American Sand-Banum Co, 9 Rockefeller Plaza, New York, N. Y. 4-page leaflet describes application of Sand-Banum to solve corrosion problems in refrigerating plants. Instructions for use included.

51 WATER TREATMENT—Elgin Softener Corp, Elgin, Ill. Bulletin No. 605 describes company's line of "Double-Check" zeolite water softeners. Enlarged views of nozzles and other design features show how loss of zeolite is prevented and how faster backwash is possible.

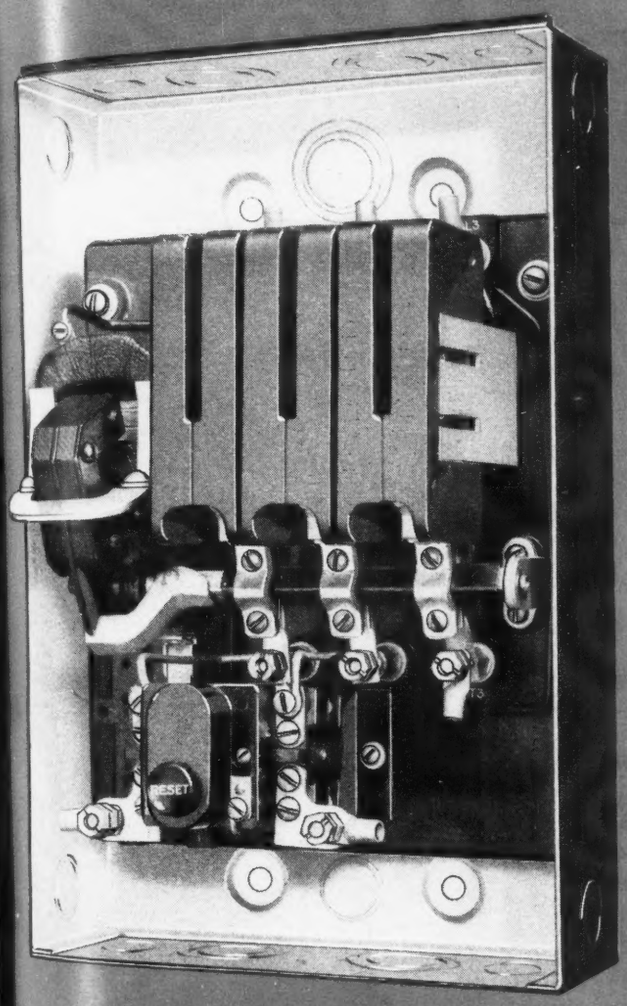
WELDING

52 WELDING—Westinghouse Electric & Mfg Co, East Pittsburgh, Pa. 4-page leaflet gives useful information on technique of seam and spot welding. Factors affecting pressure, current and timing discussed with emphasis on time of current flow. Specifications for aluminum and brass welding given, and tables list data on seam-welding mild, pickled and oiled steel, and projection welding.

53 WELDING CALCULATOR—Champion Rivet Co, Harvard Ave and East 108th St, Cleveland, Ohio. Slide-rule-type welding cost-calculator gives, when definite welding procedure is used, guides to figure individual welding costs.

54 ARC-WELDING SYSTEMS—General Electric Co, Schenectady, N. Y. GEA-569F describes and illustrates G E

NEW! An Outstanding Improvement in A.C. Motor Control



NEW! These Eight Important Cutler-Hammer Improvements

Bulletin 9586 Size 2 C-H Automatic Starter

NEW semi-enclosed arc shields with carbofrax inserts. Readily removable as individual units from front. No headroom needed. New blowout coil and arc shield design particularly effective in rupturing peak current arcs.

NEW larger magnet structure greatly increases life.

NEW No. 489 overload with pedestal mounting; arranged for easy removal from front of panel (C-H eutectic alloy type).

NEW high efficiency blowout coil design.

NEW heavier forged copper contacts with cadmium plating. Arranged for convenient inspection or replacement.

NEW electrical interlocks with double break silver contacts. Space and drilling for one extra interlock is provided on panel.

NEW moulded Thermoplax dead back panel arranged for 3 point support. Of particular interest to machinery manufacturers who purchase open panel starters.

NEW modern design enclosing case with lift-off cover. Light and roomy interior for easy installation.

The Cutler-Hammer Size 2 Automatic Starter

(Handles up to 15 H.P. 220 Volts and 25 H.P. 440-550 Volts)

This *new* C-H size 2 across-the-line Automatic Starter is an important addition to the Cutler-Hammer line of A.C. Control. Its design embodies the very latest C-H electrical control principles and it is built specifically to handle more-than-average loads.

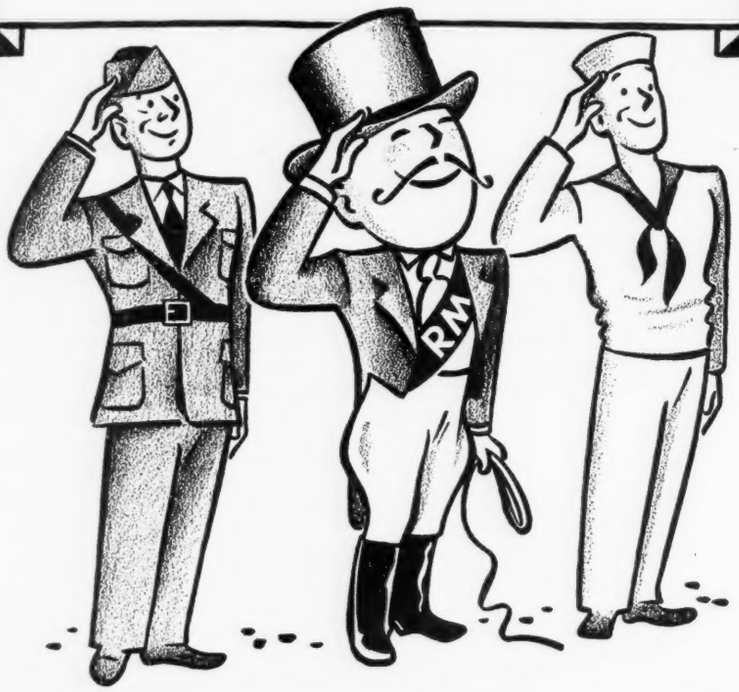
Its endurance on the job is no surprise when you stop to consider these major improvements: *new, heavier,* cadmium-plated, forged copper contacts; *new* larger and heavier duty magnet structure; *new* Thermoplax dead back panel; *new* high efficiency blow-out coil construction; and *improved* eutectic alloy thermal overload protection. These modern features add up to real service, real dependability . . . to Cutler-Hammer world-famous dependability.

And yet, for C-H's superior performance and outstanding durability, you need pay no more. You'll find the cost of this new Starter surprisingly low. And you'll also find that it's just as economical to keep on the job as it is to buy. Write at once for further information. CUTLER-HAMMER, Inc., 1358 St. Paul Ave., Milwaukee, Wis. Associate Canadian Cutler-Hammer, Ltd., Toronto.

CUTLER-HAMMER
MOTOR CONTROL
C-H

Dust Safe **VERTICAL** *Contacts*

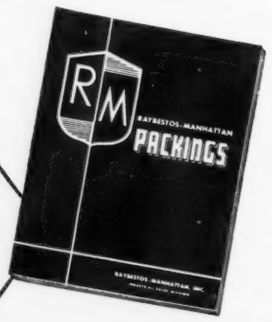
R/M PACKINGS GO "ALL OUT" FOR *National Defense*



Industrial America, fighting grimly to exceed its own capacity in producing tools, power, raw materials and arms, has an experienced volunteer in R/M Packings, a trained organization of rubber and asbestos specialists, and a line of products that can deliver results right now!

Raybestos-Manhattan packings are keeping more steam and oil and gas and water and corrosive chemicals under efficient control than ever before in history. This famous line is proving its worth under the greatest pressures and most vital emergencies ever known. It is showing the emergency value of 40 years of asbestos and rubber specializing. It is teaching the real worth of a complete line in the fewest possible numbers. It is keeping machines at work.

Call your R/M distributor. Lay your packing problems in his lap. He's waiting for your call.



This simple, complete, condensed and cross-indexed catalog will simplify packing selection in your plant. Own your own free copy. Just call your R/M distributor or write us for a copy.

INDUSTRIAL SALES DIVISION

RAYBESTOS-MANHATTAN, INC.

Makers of Packings for Every Industrial Use

BRIDGEPORT, CONN. MANHEIM, PA. NORTH CHARLESTON, S. C. PASSAIC, N. J.

multiple-operator arc welding systems for manual or machine welding with metallic or carbon electrodes.

OTHER EQUIPMENT

55 TESTING MACHINES — Baldwin Southwark Div, Baldwin Locomotive Works, Philadelphia, Pa. 40-page bulletin, illustrated with more than 50 charts and photographs, pictures company's testing machines in capacities from 20,000 to 4,000,000 lb. General specifications and description of operation of standard Southwark-Tate-Emery universal testing machines included. Second section is devoted to accessories such as control apparatus, load maintainers, etc.

56 CEMENTS—Smooth-On Mfg Co, 570 Communipaw Ave, Jersey City, N. J. Folder shows how to waterproof and patch concrete walls and floors, and how leaks in wells, cellars, etc, can be stopped with Smooth-On cements.

57 LENSES—Holophane Co, 342 Madison Ave, New York, N. Y. 16-page bulletin describes three Controlenses with different light characteristics for use with fluorescent lamps. Describes optical performance of each, lists advantages and shows how results can be predicted. Also illustrates design equipment using lenses.

58 METAL SPRAY—Metallizing Co of America, 562 West Washington Blvd, Chicago, Ill. 52-page bulletin entitled, "The History, Purpose and Practice of Metallizing", contains a brief history of the process, instructions for surface preparation, and picture applications showing uses throughout industry.

59 FLOURESCENT FIXTURES—Mitchell Mfg Co, 2525 Clybourn Ave, Chicago, Ill. Pocket catalog No. 240 pictures entire line of commercial and industrial fixtures, with brief engineering and sales data on each.

60 WIRE ROPE—Hazard Wire Rope Div, American Chain & Cable Co, Wilkes-Barre, Pa. 24-page booklet gives tables of breaking strengths for all commonly used rope constructions and offers constructive information on effects of acceleration, and suggestions for correcting operating factors affecting safety, such as abrasion, bending fatigue, reverse bends, spooling, kinking, etc.

61 INSULATING VARNISH — Irvington Varnish & Insulator Co, Irvington, N. J. 34-page manual describes all varnishes usually required based on their relative importance in terms of extent and variety of use. Subject matter covers 31 different Harvel and Irvington insulating varnishes, paints and enamels, giving characteristics, uses, and applications of each.

62 COPPER—Revere Copper & Brass, Inc, 230 Park Ave, New York, N. Y. "Copper and Copper Alloys for Power Plants" covers copper and alloy tubing for power plant, including condenser tubes, tube sheets, copper water tube, brass and copper pipe, pole-line hardware, etc.

63 COMPRESSORS — Pennsylvania Pump & Compressor Co, Easton, Pa. 4-page bulletin No. 195 illustrates, describes and gives typical applications of air and gas compressors made by company. Important characteristics and general features listed.

64 POWER PLANT INSURANCE — Hartford Steam Boiler Inspection and Insurance Co, Hartford, Conn. 8-page folder outlines coverage of policies written by company, and services available to policyholders. Comparative chart showing amount of policies written by competitive companies included.

65 COPPER — Phelps Dodge Copper Products Corp, 8-page bulletin lists advantages, characteristics and applications of PDCP copper. Also includes electrical resistance of copper, with engineering and mechanical properties.

66 BUILDING MAINTENANCE — Flexrock Co, 2377-A Manning St, Philadelphia, Pa, 74-page handbook has technical information for plant managers, maintenance men and superintendents. Shows how to do many odd jobs at lower cost with better results, and presents numerous ideas that save time and money. Non-technically written.

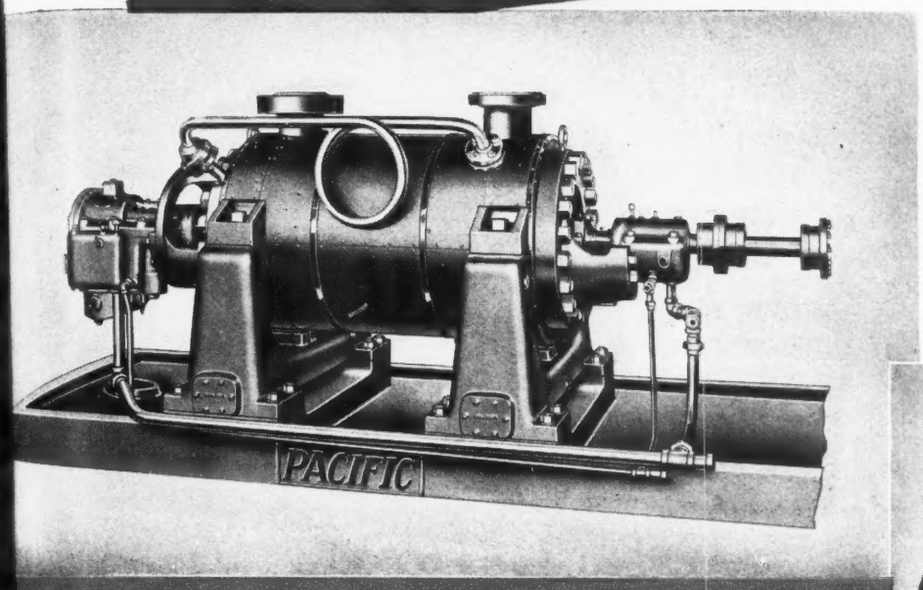
PACIFIC

Pre-Tested Design and Engineering

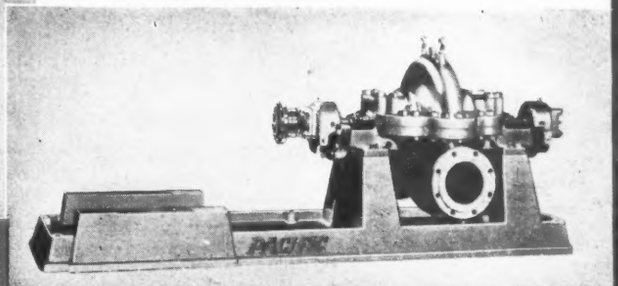
ASSURES YOU TROUBLE-FREE EFFICIENT PUMPING!

PACIFIC Pumps meet successfully the requirements of industry in the pumping of high temperature and often corrosive liquids. PACIFIC Pump design provides safety, simplicity and compactness that results in dependable, economical pumping. Each type of PACIFIC Pump is engineered for a special range of pumping conditions. Each pump is tested at far greater pressures than will likely be encountered in service. The reliability of PACIFIC High Pressure Pumps performance has won the unqualified recognition of power plant engineers throughout the world as the foremost pumps in this field.

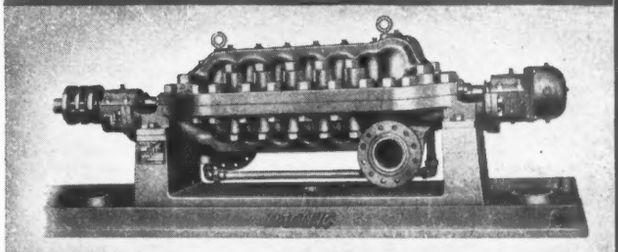
Full details of PACIFIC Pump design and engineering are available to power plant executives. Write for Bulletin 74.



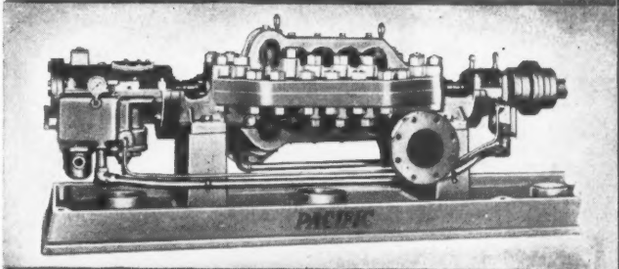
PACIFIC Type I
Boiler Feed Pump installed by a leading Mid-West Utility.



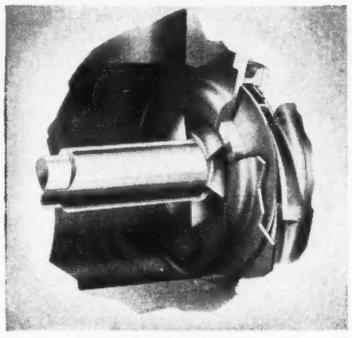
PACIFIC Type KH—Single-Stage Horizontally Split-Shell Boiler Feed Pump installed by a major refinery.



PACIFIC Type JH—7-Stage Boiler Feed Pump installed by the city of Pasadena, California.



PACIFIC Type JH—5-Stage Boiler Feed Pump installed by the city of Glendale, California.



View of PACIFIC first-stage impeller showing how mixed flow impeller vanes extend out into the suction eye. Low suction velocities are obtained through the design of the large suction bay and large area of first-stage impeller.

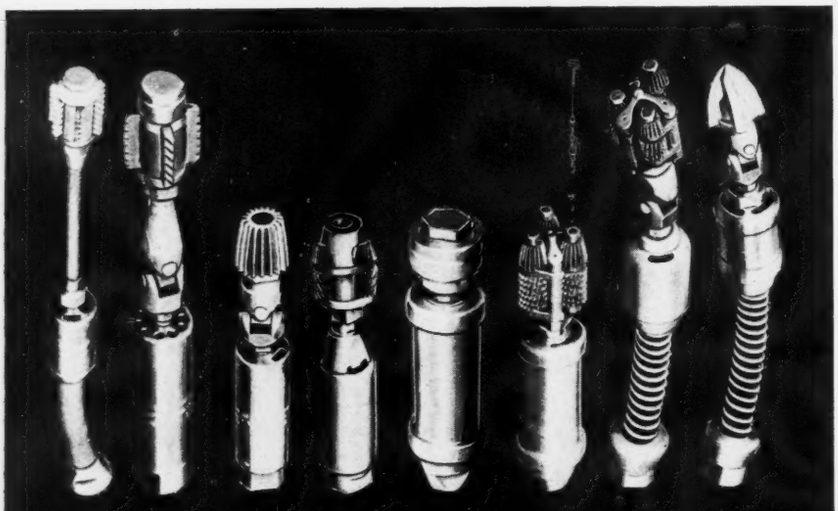
PACIFIC PUMP WORKS

***EXECUTIVE OFFICES & PLANT:* HUNTINGTON PARK, CALIFORNIA • *EXPORT OFFICE:* 30 ROCKEFELLER PLAZA, NEW YORK • *SALES & SERVICE:* OFFICES IN PRINCIPAL CITIES IN THE UNITED STATES**

***Affiliated Companies:* Clark Bros. Co., Olean, N. Y.,** Manufacturers of Engines and Compressors; **Dresser Manufacturing Co., Bradford, Pa.,** Manufacturers of Pipes, Couplings, Sleeves, etc.; **The Bryant Heater Co., Cleveland, Ohio,** Manufacturers of Heating and Air Conditioning Equipment.

PACIFIC PUMP WORKS
PACIFIC
HUNTINGTON PARK CALIF

PACIFIC *Boiler Feed* PUMPS



FOR *BETTER* TUBE CLEANING SPECIFY A WILSON CLEANER

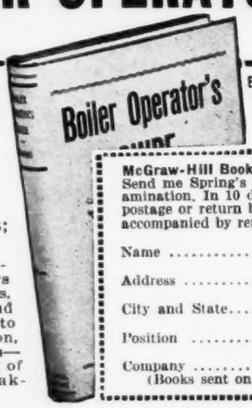
For *quickly, thoroughly* and *economically* removing either hard or soft scale, sludge, or other fouling deposits from straight or curved ferrous or non-ferrous tubes of large or small diameter, there is a specially designed Wilson tube cleaner, cutter head, brush or other accessory.

Wilson tube cleaning equipment is proving its *extra* power, *extra* speed, *extra* efficiency and *extra* economy in hundreds of power plants generating power for the production of materials and equipment for our national defense.

There is a Wilson tube cleaner to solve *your* tube cleaning problem. Let us show you what *rapid, thorough, economical* tube cleaning can save you. Write for the name of our representative nearest to you or send for a copy of our thirty-six page catalog describing and illustrating the complete line of Wilson tube cleaning equipment.

THOMAS C. WILSON, Inc.
PIPE AND TUBE CLEANERS EXCLUSIVELY
47-28 37th Street Long Island City, N. Y.

THIS NEW BOILER OPERATOR'S GUIDE . . . can mean money to you!



JUST OUT! Here's information of the most priceless sort for you — whether you want to improve your ability as an inspector or to utilize effective inspection methods in the more efficient, safer operation and upkeep of your own boilers.

Helps you meet everyday problems; Prepares you for license exams

With hundreds of typical examination questions and answers as well as complete instructions, this book presents fully and plainly the things you want to know about proper installation, operation, and care of boilers—the things that prevent dollars of loss in reduced efficiency, breakdown, or even accident.

By H. M. Spring, Jr. 353 pages, 6 x 9 241 illustrations $3.00

EXAMINE A COPY FOR 10 DAYS ON APPROVAL

McGraw-Hill Book Co., 330 W. 42nd St., N. Y. C.
Send me Spring's Boiler Operator's Guide for 10 days' examination. In 10 days I will send you $3.00, plus few cents postage or return book postpaid. (We pay postage on orders accompanied by remittance.)

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(Books sent on approval in U. S. and Canada only.)

Power Lines

(Continued from page 122)

larger than 500,000 circular mills be not carried in stock, but available on order.

Purpose of this recommendation is to focus production, distribution and use on the recommended sizes, thus eliminating unnecessary copper inventories. According to the National Electrical Contractors Association, which sponsored the program, appreciable copper tonnages are now tied up in inventories of slow-moving sizes, mostly in the upper-size range, whose place could be filled more efficiently, from an electrical standpoint, by smaller cables connected in multiples.

St. Mary's Hospital Adds More Power

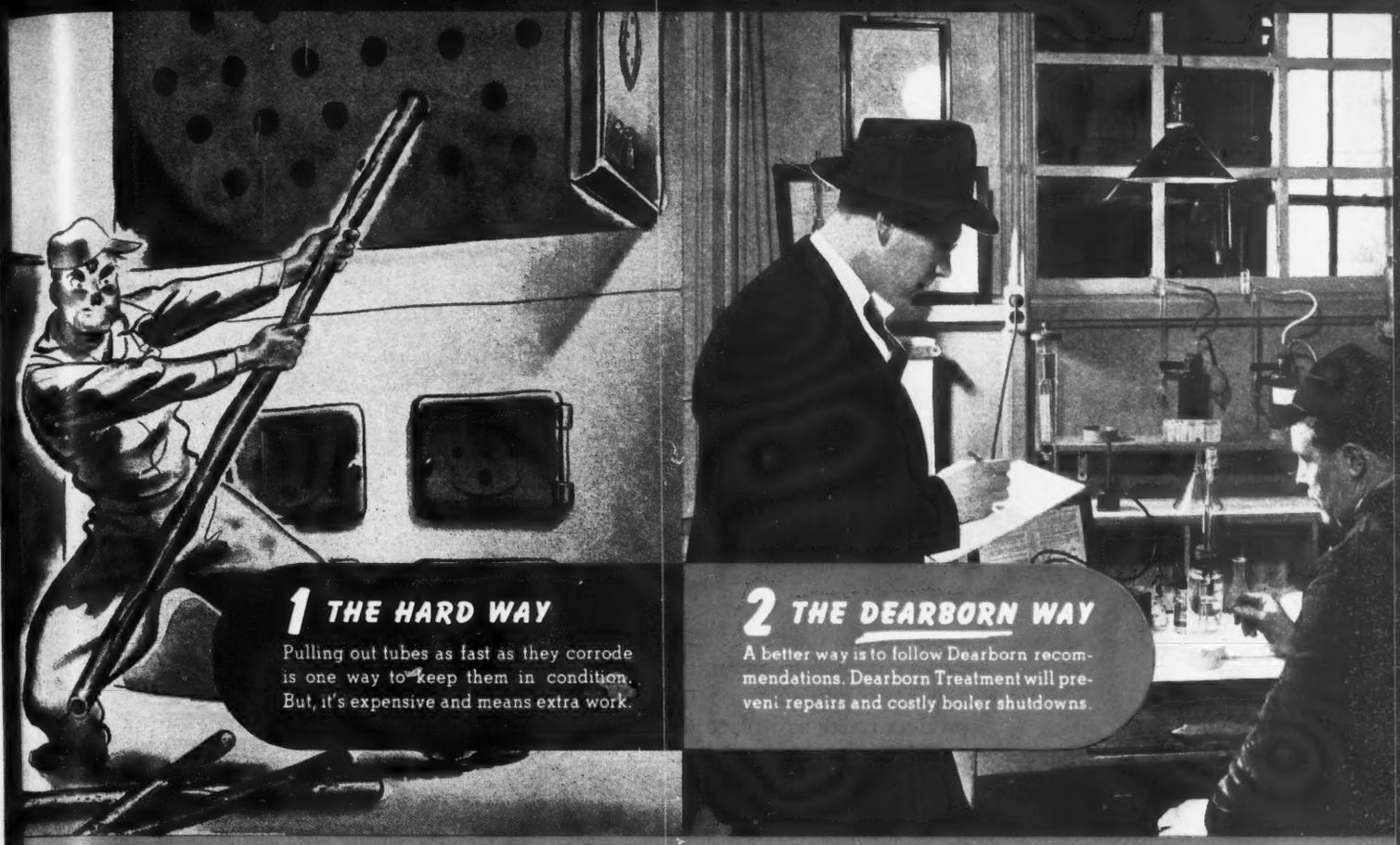
St. Mary's Hospital, of San Francisco, Calif., has ordered a boiler and steam-generating unit, to be delivered in October of this year. John H Herzog, chief engineer of the hospital, is supervising the addition. The boiler is a 2100 sq ft, B & W, Stirling type, 200-lb pressure, and will be fired with Leahy multi-jet combination gas and oil burners.

The new generating unit will be a 50-kw, 0.8 pf, Elliott turbine, operating at 3600 rpm. It will be geared to an 1800-rpm, 4-wire 208/120-volt ac generator, and will exhaust to heat and process at from 0 to 2 lb. This unit will normally operate 18 hours per day, and carry only enough power load—laundry, etc—to maintain a perfect heat balance, and at the same time be ready to carry most of the lighting load in an emergency.

Mr Herzog, an old friend of POWER's, writes: "All dc has been eliminated in the hospital and we are gradually adding new ac generating equipment to insure efficient and dependable service." He also stated that during the last six months he has installed a 15-ton, 6 x 6, 270-rpm belt-driven York ice machine, and a 5-hp Rix air compressor, both for the ice plant.

OBITUARIES

LORIN E IMLAY, 76, hydraulic power engineer, died at his home in Niagara Falls, N. Y., June 9. He installed seven of the original 5000-hp generators for the first upriver plant of the Niagara


1 THE HARD WAY
Pulling out tubes as fast as they corrode is one way to keep them in condition. But, it's expensive and means extra work.
2 THE DEARBORN WAY
A better way is to follow Dearborn recommendations. Dearborn Treatment will prevent repairs and costly boiler shutdowns.

TWO WAYS to keep your Boiler Tubes and Sheets free from CORROSION

All boiler waters contain dissolved oxygen and other corrosion accelerators which weaken tubes, sheets, drums, and feed lines to the point where costly repairs are necessary.

You can prevent corrosion in your boilers with Dearborn Water Treatment and Engineering Service. Dearborn engineers first make a thorough study of water and plant operating conditions. Then, trained technicians in modern Dearborn laboratories make a complete chemical analysis of the feed-water. Next, the proper treatment and control methods are recommended. Feeding equipment is then installed and instructions given in water testing and treatment control. Finally, frequent checkups insure satisfactory results.

Dearborn Treatment is balanced to provide full protection against scale as well as against corrosion, and to reduce the possibility of steam contamination. Treatment can be controlled to disintegrate scale which may already be present, without boiler shutdowns. See your Dearborn representative.

DEARBORN CHEMICAL COMPANY
Dept. D, 310 S. Michigan Avenue, Chicago, Ill.

Prevent Water Troubles
THE DEARBORN WAY

Dearborn
TRADE MARK REGISTERED

WATER TREATMENT and Engineering Service

CHICAGO · NEW YORK · LOS ANGELES · TORONTO and PRINCIPAL CITIES

TO POWER PLANT ENGINEERS:

If you are not familiar with the advantages of Santosite for elimination of dissolved oxygen in boiler feedwater, we invite you to write us about this product today and place your order for a trial amount to be delivered as soon as stocks are available.

Because of the increased demand for Santosite, it has been necessary for us to limit sales to some extent for the present. We are pleased to announce, however, that preparations are being made which will enable us soon to meet all needs. MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, St. Louis, U. S. A. District Offices: New York, Chicago, Boston, Detroit, Charlotte, Birmingham, Los Angeles, San Francisco, Montreal.

QUICK FACTS ABOUT SANTOSITE

1. About 30 parts per million parts of feedwater required for effective protection against oxygen corrosion.

2. Frequent testing for oxygen unnecessary. Simple Monsanto test for sodium sulfite at periodic intervals gives reliable check on variations of oxygen due to overloads or leaks before damage can be done.

3. An anhydrous crystalline product; easily handled, stored and applied.

4. Economical to use.

SANTOSITE

MONSANTO CHEMICALS
SERVING INDUSTRY . . . WHICH SERVES MANKIND

LET'S GO! U.S.A. KEEP 'EM FLYING!

Hudson Power Co. His half-century engineering career took him to many parts of the United States and Hawaiian Islands. Mr Imlay joined the Westinghouse company in 1894 as an engineer in manufacture and installation of electrical apparatus. He was consulting engineer for the present Niagara Falls Power Co from 1921 to 1924 and in 1927 was made statistical engineer for the Buffalo, Niagara and Eastern Power Corp. He held the same position with Niagara Hudson from 1930 until his retirement three months ago.

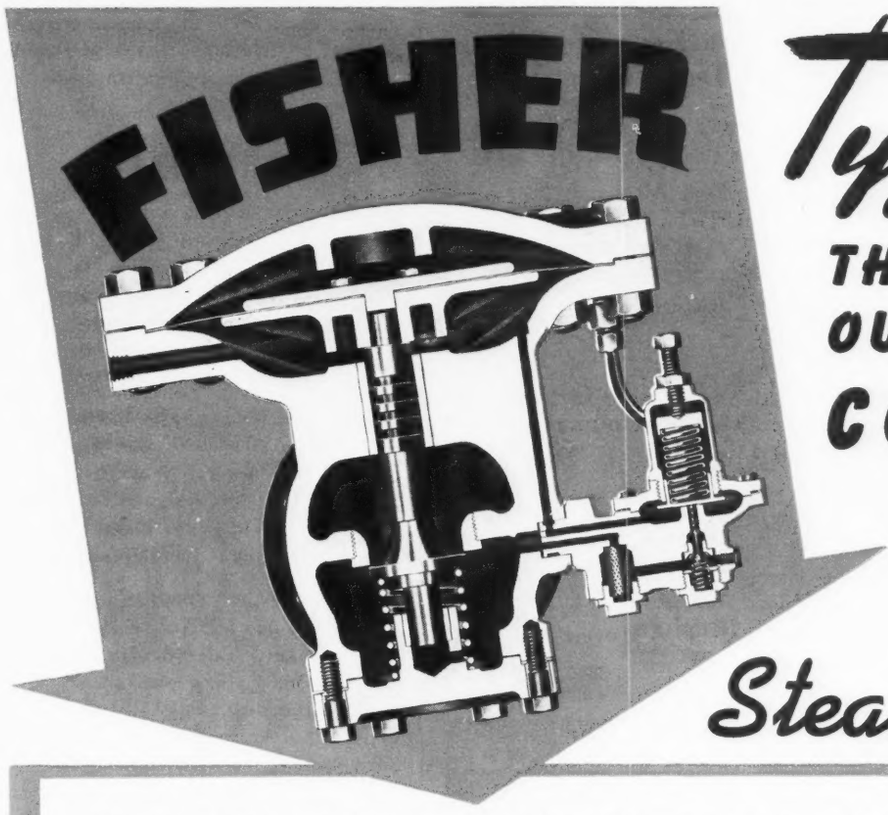
SIDNEY A REEVE, 75, retired consulting engineer and professor of steam and hydraulic engineering at Worcester Polytechnic Institute from 1896 to 1906, died at his home in Nyack, N. Y., on June 12. He was a native of Dayton, Ohio, and was graduated from Sheffield Scientific School at Yale University in 1885. After leaving Worcester he lectured at Harvard and Annapolis. He was known as an outstanding authority on thermodynamics.

EDWARD M JOLLEY, one of the most widely known sales engineers of the Kansas, Missouri, Nebraska and Iowa area, succumbed to a heart attack on July 3. He has represented the Marley Co since the first part of 1938, operating out of the main office in Kansas City, Kan. He was graduated in Mechanical Engineering in 1928 from the Unversity of Nebraska, and was employed from 1928 to 1937 by the Worthington Pump & Machinery Corp.

GUY A BARKER, 50, manager of public utility and electrical products departments of Johns-Manville, died June 18 at his home in Scarsdale, N. Y. He began his career with Johns-Manville as a sales engineer, later serving as Pacific Div sales manager and Chicago district sales manager, before coming to New York in 1933 to become manager of the electrical products dept. He was made manager of the company's public utility and electrical depts in April of this year.

WARREN G JONES, president of W A Jones Foundry & Machine Co, Chicago, Ill., passed away June 6 at his home in River Forest, Ill. Mr Jones was very well known in industrial and engineering circles. He was born in Chicago in 1890 and entered his father's firm in 1910. He had been president since 1925, and was also vice president of the Sackett Screen & Chute Co of Chicago.

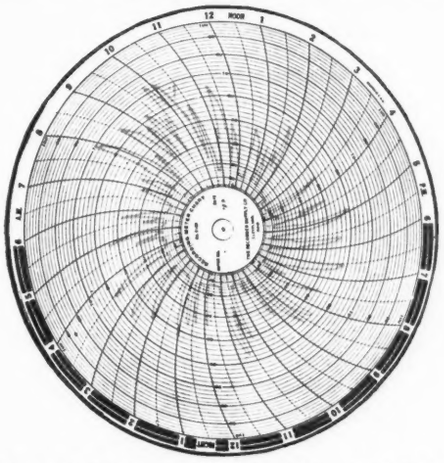
JOHN C CLARK, 68, steam plant engineer and later an electrical operating man with the Beverly, Mass., Gas &

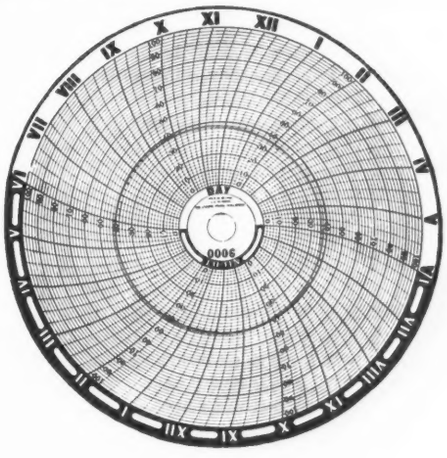


Type 92

THE YEAR'S OUTSTANDING CONTROL Valve FOR Steam Service

Announced just one short year ago, these Fisher Pilot-Operated Reducing Valves have already won the enthusiastic approval of engineers everywhere because of *EXTREMELY ACCURATE PRESSURE CONTROL* and *TIGHT CLOSURE UNDER NO-FLOW CONDITIONS.*





TYPICAL REGULATION

These unretouched flow and pressure regulation charts from a Fisher Type 92 installed in the Central Fibre Products Company plant at Quincy, Illinois, demonstrate the extreme accuracy of these reducing valves. This particular Type 92 with an inlet pressure that varies from 200 to 170 pounds per square inch maintains a reduced pressure of 39 pounds even though the steam flow through the valve, as indicated in the left hand chart, fluctuates rapidly from a maximum of 7,000 lbs. to 2,000 pounds per hour.

TYPE 92 FEATURES

★ May be used with downstream control line or as self-contained unit. ★ Two interchangeable pilot assemblies for high or low pressure service. ★ Ribbed construction adds extra strength to the body and diaphragm casings. ★ Requires no auxiliary operating medium. ★ Extremely compact requiring minimum installation space. ★ Unusually large capacity. ★ Reduced pressure ranges 3 - 200 lbs. per square inch. ★ Inlet pressure up to 250 pounds at 410 degrees F.

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FISHER GOVERNOR COMPANY

• 415 FISHER BUILDING •

MARSHALLTOWN, IOWA

GRAPHITE *makes 'em* BETTER

Graphite, as processed by Joseph Dixon, adds advantages you'll otherwise miss in joint seals and greases.

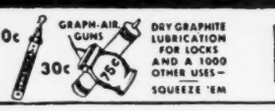
DIXON'S PIPE JOINT GRAPHITE COMPOUND keeps all threaded, flanged and gasketed joints lubricated yet tight against air and all aqueous solvents—water, acids, alkalies, steam, etc. Write for booklet D-94.

DIXON'S GRAPHITE SEAL does the same for joints where non-aqueous solvents are encountered—gasoline, oil, etc. Booklet DS-94.

DIXON'S CUP & PRESSURE GUN GRAPHITED GREASE lubricates better and longer than ordinary grease particularly wherever excessive heat, pressure, or moisture make trouble. Graphite gives guts to greases, and Dixon's Graphited Grease is tops for purity, uniformity, and correctness of blend. Booklet R-94.

JOSEPH DIXON CRUCIBLE CO.

Jersey City, New Jersey



632

ALLPAX

THE PACKING THAT "PACKS ALL"

The ONE packing for ALL stuffing boxes

You don't have to carry a lot of different packings for different purposes when you use ALLPAX. This universal all purpose packing—made in square cross section for easy fitting—can be used for any and all stuffing boxes—for any fluid or pressure. One size fits all sizes of stuffing boxes.

Here's the long wearing, non-hardening packing that holds tight, reduces friction and never scores the rod—economical, efficient time and service proved under all conditions to be the right packing for *your* requirements.

Write at once for full details.

THE ALLPAX CO., INC. Mamaroneck, N. Y.

Distributors Everywhere

KEWANEE FIREBOX BOILERS

Extra Strength . . . for Heavy Duty

Wherever heavy duty demands extra strength . . . Kewanee Steel riveted boilers are preferred. For the known strength assured by **Steel + Rivets,** supplemented by extra stout stays and braces in the boiler shell, mean many added years of service.

Ask our nearest office or write for Cat. 96 K-VIII

KEWANEE BOILER CORPORATION Kewanee, Illinois

division. American Radiator and Standard Sanitary Corporation

Electric Co, died at his home in Beverly on June 15. He was a native of Henniker, N. H., and had been employed by the company for 30 years.

PERSONALS

S D DISTELHORST, sales promotion manager of Cochrane Corp, Philadelphia, was awarded a professional engineering degree by Purdue University on June 8. He was graduated from Purdue in 1935 with a Bachelor of Science degree in electrical engineering.

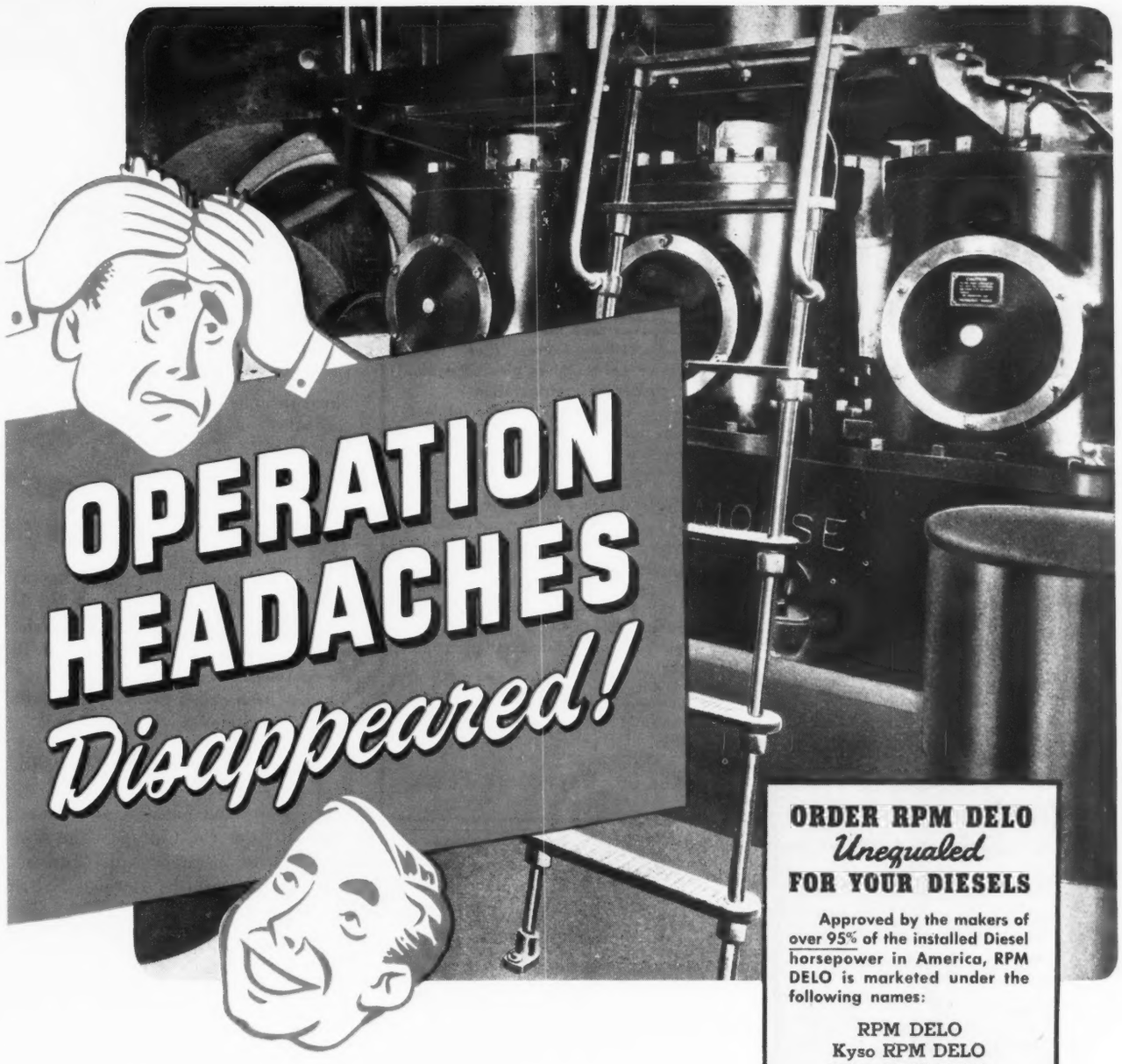
EDWIN M WILLSE, who has held an executive position with the Worcester Salt Co for several years at Silver Springs, N. Y., has resigned to become superintendent of power plant, Ft Bend Utilities Co., Sugar Land, Texas.

WILLIAM F CRAWFORD, vice president since 1937, has been elected president of the Edward Valve & Mfg Co, East Chicago, Ind., filling the vacancy created by the death of W W Crawford earlier this year. The new company head has been associated with the organization since 1931, and has had active charge of manufacturing, research, advertising and sales-promotion activities for some time.

E S BISSELL has been made vice-president of the Mixing Equipment Co, Inc, of Rochester, N. Y. Prior to his promotion, Mr Bissell was technical sales manager of the company. Since joining the company in 1937 Mr Bissell has been successively director of research and head of development and market study, a position he held until his present appointment.

FRANK O WALLENE, utilities director of the City of Cleveland from 1936 to 1940, has been appointed chief engineer of the Stowe Stoker Div, Johnston & Jennings Co, Cleveland, Ohio. Equipment covered by Mr Wallene's patents will be manufactured by the company. Mr Wallene is a member of the Ameri-

Frank Wallene



OPERATION HEADACHES *Disappeared!*

ORDER RPM DELO
Unequaled
FOR YOUR DIESELS

Approved by the makers of over 95% of the installed Diesel horsepower in America, RPM DELO is marketed under the following names:

RPM DELO
Kyso RPM DELO
Sohio RPM DELO
Signal RPM DELO
Caltex RPM DELO
Imperial RPM DELO

Ask your Diesel engine manufacturer or distributor for the RPM DELO supplier in your locality.

"WE first tried four other well-known Diesel engine oils." Doesn't that sound familiar to you? But when C. A. Carter, President and Treasurer of Randolph Milling Company at Ava, Illinois, switched to RPM DELO for his 3-cylinder, 210 h.p. FAIRBANKS MORSE DIESEL ENGINE—his troubles were over!

Here's what Mr. Carter says:

"The freedom we enjoy now from ring-sticking and carbon deposits has greatly reduced our overhauls and operating cost. The engine-cleaning characteristics of your oil are such that we now operate twice as long between inspections and this increased efficiency is of the utmost importance to us.

"Our Fairbanks Morse Diesel Engine has been operated on RPM DELO for 15,000 hours under severe conditions and due to the excellent results we have enjoyed, we can highly recommend it."

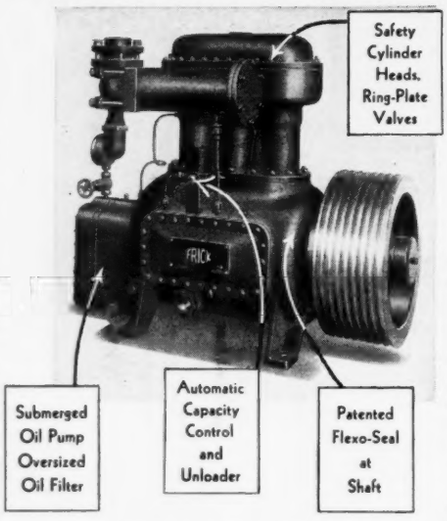
THE MORAL—Try RPM DELO in *your* Diesels—stops ring-sticking, ends sludge, reduces friction—has doubled engine-life!

RPM DELO
REG. TRADE-MARK
DIESEL ENGINE LUBRICATING OIL

STANDARD OIL COMPANY OF CALIFORNIA

Distinctive Advantages Announced for the New

Eclipse Refrigerating Machines


Safety Cylinder Heads, Ring-Plate Valves
Submerged Oil Pump Oversized Oil Filter
Automatic Capacity Control and Unloader
Patented Flexo-Seal at Shaft

Don't buy ANY Freon-12 compressor until you've seen the new Frick Eclipse line! Built in three sizes, these phenomenal machines give capacities up to 60 tons refrigeration . . . in units so compact, light, efficient, and quiet they can be installed almost anywhere . . . and at a material saving over older types!

Only in the Eclipse line can you get all the exclusive advantages shown, plus such features as higher operating speeds (up to 900 r.p.m.), force-feed lubrication throughout, direct-connected motor drive when desired, pistons with 5 rings, etc., etc. Nearly 60 years' refrigerating experience built into them.

1. **Patented Flexo-Seal at Shaft.**
2. **Safety Cylinder Heads with Ring Plate Valves.**
3. **Automatic Capacity Controls and Unloaders.**
4. **Submerged Oil Pump and Over Sized Screen.**
5. **"Parallel" Operation, using Frick Oil Equalizing System.**

Write, wire or phone your Frick Branch or Distributor for full details today. Or, get in touch with

Frick Co., Waynesboro, Penna.

When you need grates

Specify **BATES**

FOR LONG-TIME ECONOMY

FILLET WELD

BATESGRATES

—One Piece Construction

Each intersection, and consequently, each complete panel of Batesgrates, is strictly one piece. Non-slip, sharp top edge, self cleaning cross bars like the ridge of a roof. No cracks, joints, or acute angles. No grooves to hold grease and dirt and create slippery spots. Batesgrates are an engineered assembly of bars—all bars work.

Write for engineering Catalog No. 937.

WALTER BATES COMPANY

208 S. LaSalle St. Chicago, Ill.

can you do this . . .

- - with the Fire Brick Cement you are using?

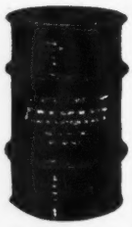
This unretouched photo, showing a section of an arch with bricks laid-up with Adamant Cement, is one more proof of the outstanding bonding strength of Adamant. The cement makes the joints as strong as the brick they bond!

● *Just how strong?* In a report on impartial laboratory tests, made by one of America's leading technical institutes, the average modulus of 5 test joints showed

ADAMANT FIRE BRICK CEMENT

has a BONDING STRENGTH of 800 lbs. per sq. in. at room temperature — 1270 lbs. per sq. in. at 2600° F.

Ask about ADAMANT; write—



ADAMANT has a P.C.E. of over 3000° F.

BOTFIELD REFRACTORIES COMPANY

784 S. Swanson St., Philadelphia, Pa.
In Canada, Canadian Botfield Refractories Co., Ltd., 171 Eastern Avenue, Toronto

can Society of Mechanical Engineers and the Cleveland Engineering Society.

H M Sliter has been appointed assistant manager of General Electric Co's Central Station Dept in New York district, effective July 1. Mr Sliter began his association with GE in 1908 after having been graduated from Cornell University with a degree in mechanical engineering. In February, 1910, he was assigned to the Switchgear Div, Sales Dept and went to New York in 1912 as a switchgear specialist. Late in that year he was made resident agent at Elmira, where he remained until 1927. Since then he has been active in general sales work in the utility field, with headquarters in New York.

BUSINESS ITEMS

Worthington Pump & Machinery Corp announces appointment of R M Cleveland, a veteran of 24 years service with the company, as manager of its Boston office. He succeeds W A Finn, who has been called to active duty with the United States Navy.

Herman Nelson Corp, Moline, Ill., announces that it has purchased the entire assets and business of Autovent Fan & Blower Co, Chicago. The business will be operated as the Autovent Fan and Blower Div, Herman Nelson Corp.

Quimby Pump Co plans factory addition to plant No. 1. New building will be located on 10-acre tract at New Brunswick, N. J., and will cover 22,000 sq ft. It is expected that production at new addition will start late this year.

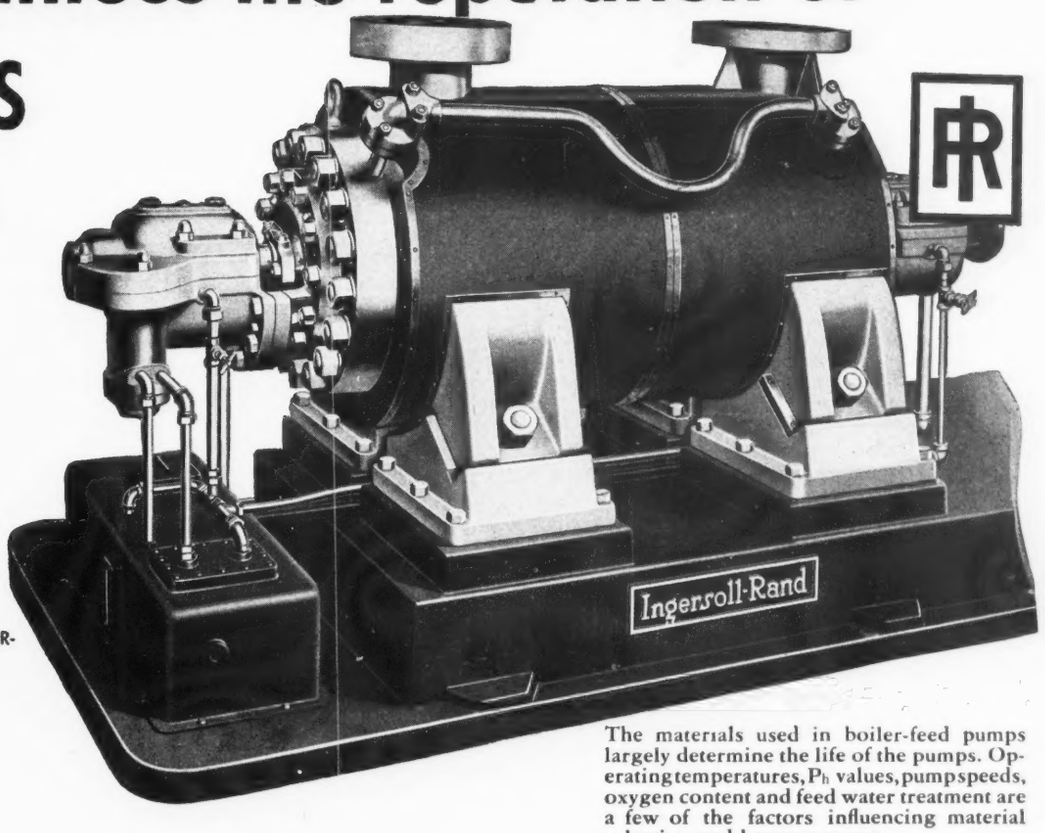
West Penn Power Co announces appointment of D E Winslow as purchasing agent for the system. He will succeed Russell Poe, who retired from active service June 1, after having been with the company for 35 years. J H Fairley will become assistant purchasing agent. W A Garber, an engineer from the Lines Engrg Dept, has been transferred to newly created position of buyer in the Purchasing Dept.

Buffalo Niagara and Eastern Power Corp announces election of Arthur W Jackson as treasurer at a recent meeting of the Board of Directors. Mr Jackson succeeds George C Brett, recently moved to New York to take up duties as controller of Niagara Hudson Power Corp. Laurence W Buchanan, assistant treasurer of Buffalo Niagara Power Corp, will succeed Mr Jackson as assistant treasurer of Buffalo Ni-

Ingersoll-Rand Metallurgy

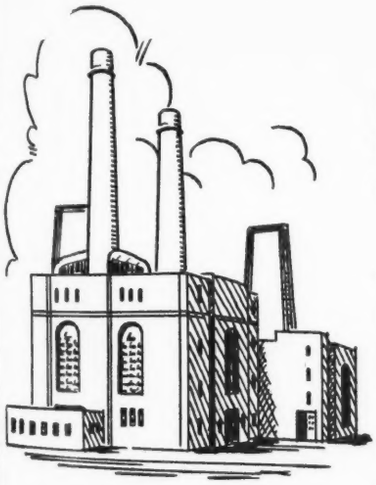
guarantees the reputation of

THOUSANDS of BOILER FEED PUMPS



CLASS CHT BOILER-FEED PUMP

The materials used in boiler-feed pumps largely determine the life of the pumps. Operating temperatures, P_h values, pump speeds, oxygen content and feed water treatment are a few of the factors influencing material selection and heat treatment.



Ingersoll-Rand has outstanding metallurgical facilities and heat treating plants. Metallurgists with years of practical experience on boiler-feed pumps select the materials and control the heat treatments.

A recent field survey by I-R experts resulted in the development of new means of combating corrosion in boiler-feed pumps. This assures the selection of improved materials for certain installations. Such research is part of Ingersoll-Rand's determination to maintain leadership.

Ingersoll-Rand's experience in building Cameron boiler-feed pumps, as well as its experience on all types of pumps handling corrosive liquids, and its wide experience in the selection of materials for condensers, rock drills, air and gas compressors, Diesel and gas engines, etc., assures the user that his pump will be constructed of the very best materials for his particular installation. Specify Ingersoll-Rand for dependability.

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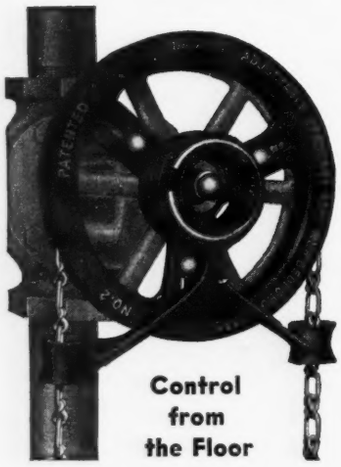
Make Your Overhead Valves SAFE And Easy to Reach---



Control from the Floor

With the Babbitt Rim for Valves you eliminate danger and banish the step-ladder. You can now place your valves wherever they come economically and conveniently. They fit any valve. Let us tell you more about them. Write today.

BABBITT STEAM SPECIALTY CO.

New Bedford, Mass.

TOUGH REPAIR for BROKEN CONCRETE

Avoid accidents! Prevent costly delays! Repair holes, cracks, broken places in concrete floors or resurface an entire area with the durable RUGGEDWEAR RESURFACER. No chopping or chipping required. Merely sweep out the spot to be repaired—mix the material—trowel it on. Holds solid and tight right up to irregular edge of old concrete. Cellulose-Processed to provide a firmer, tougher, smoother, more rugged wearing surface. Used indoors or out. Dries fast. Low in cost.

Valuable 74-page "HAND BOOK OF BUILDING MAINTENANCE" available to those requesting on business letterhead.

MAKE THIS TEST!

FLEXROCK COMPANY
2377 Manning St., Phila., Penna.

Please send me complete RUGGEDWEAR information . . . details of FREE TRIAL OFFER—no obligation.

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City ..... State .....

agara and Eastern Power Corp. At the same meeting it was announced that Harold R Waldron was elected vice president of Buffalo Niagara and Eastern Power Corp.

COCHRANE STEAM SPECIALTY CO, Boston, Mass., announces addition of Samuel Reid to organization. Mr Reid will be engaged in sales engineering work, handling products of Cochrane Corp, the Hays Corp, Northern Equipment Co, Reliance Gauge Column Co and Vulcan Soot Blowers.

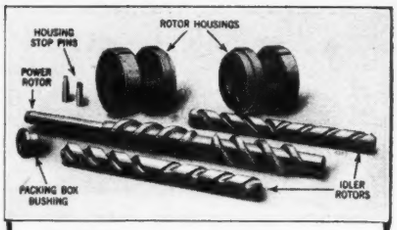
ELLIOTT CO, Jeannette, Pa., announces several personnel changes. L M Forncrook, who has been a company vice president and manager of Jeannette plant, is now vice-president in charge of operations of company's three plants, in Jeannette and Ridgway, Pa., and Springfield, Ohio. V H Peterson, general sales manager, has been elected a vice-president. He will be responsible for operation of district sales offices, all sales, advertising and service activities of three plants. W A Elliott, member of the board and executive committee, and for the past year and a half manager of Chicago district office, is now a vice-president and will be in charge of market research, field studies and administration of purchasing. M A King, for the past nine years manager of the Turbine Dept, has been appointed manager of engineering with responsibility for engineering, design and drafting of all company products.

J H H Voss Co has moved to larger and more modern building at 785 East 144th St, corner Wales Ave, New York, N. Y. The move makes available improved workshop and office facilities.

FOXBORO CO has expanded New England sales force. Elmer E Forslind, graduate of Northeastern University and for several years in various branches of public utility engineering, will be attached to Foxboro, Mass., office. William W Nelson, for the past four years a Foxboro service engineer, has been transferred to the New England staff. He is a graduate of Tufts College, with special engineering training from Boston University.

STANDARD HEATER AND OIL EQUIPMENT CO announces appointment of Alpha Steam Specialty Co, 15 Park Row, New York, N. Y., as manufacturer's representative for company line in New York metropolitan area.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS announces election of officers for coming year. Election was held at annual meeting in Toronto, Ont.

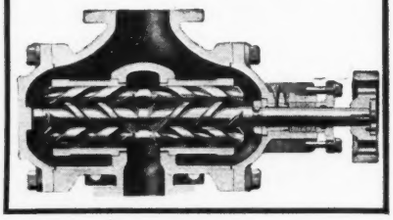


ONE . . . Packing Box Valves, Gears, Bearings . . . . NONE

Internal parts of the *De Laval-IMO Oil Pump* are easily accessible, without removal from base plate or disturbing driving motor or turbine. The three moving parts are in perfect rotational balance. Delivery at all pressures and capacities is smooth and continuous, as from a piston moving steadily forward.

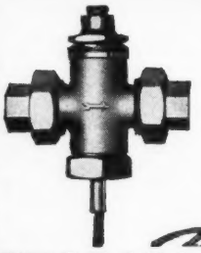
Ask for Catalog I-81.

IMO PUMP DIVISION
of the De Laval Steam Turbine Co.
Trenton, New Jersey



Tank and Process

TEMPERATURE Control at a NEW LOW COST!



STERLING THERMOTROLS

Simple, efficient, LOW COST, this new No. 150-A Tank and Process Temperature Control is effective in steam-heated hot water tanks, fuel-oil preheaters, plating baths, heat-exchangers, and processing plant applications. Versatile, for temperatures from 100° to 300° F., and pressures as high as 125 pounds. For corrosive liquids, bulb can be equipped with immersion well.

Write TODAY for Latest Bulletin

STERLING, Inc.

3713-D N. Holton Street Milwaukee, Wisconsin

STERLING, INC.

What Do YOU Look for in a Mechanical-drive Turbine?

LOW-COST BY-PRODUCT POWER?

You have it—24 hours a day, 7 days a week—when you use General Electric's Type D turbines, because they provide an economical drive for general-purpose apparatus and power-plant auxiliaries. Simultaneously, they supply low-pressure steam for process or seasonal heating. Unreclaimable losses are less than five per cent. Nozzles correctly proportioned, buckets contoured to approximate the steam expansion characteristics, low-loss packing glands—all to get more work from the energy in a pound of steam. And, where over-all plant economy is important, mechanical-drive turbines save again because of the low maintenance expense and small amount of attention required.

CLEAN STEAM FOR PROCESS?

Because no lubrication is required in the steam passages of a turbine, you can be sure of oil-free steam.

COMPLETE SAFETY?

In our improved Type D's you can be sure of *positive protection* against overspeed. If for any reason speed becomes excessive, an emergency trip device operates to instantly close a built-in combined trip and throttle valve that shuts off all steam flow. Here's complete safety available as a standard feature. Turbine drives can also be used safely in inflammable and explosive atmospheres.

LIFETIME DEPENDABILITY?

Without "time out" for maintenance or repairs, G-E turbines keep going to meet today's demands for continuous performance. They keep going even when adverse operating conditions exist, such as unusually high ambient temperatures or excessively moist atmospheres. And, in dual-drives, turbines either pick up the load instantly when called upon to do so or divide the load with the motor for the most economical heat balance.

FLEXIBILITY?

Because of their adaptability to any speeds within wide limits and the availability of reduction gear units, turbine drives permit operation of the driven equipment at its most efficient speed. Turbines built for one steam pressure can usually be adapted to another pressure by minor changes.

EASE OF SERVICING?

Take out one linkage pin, remove eight bolts, lift the valve bonnet—in less than two minutes you have completely exposed the inlet valve for inspection. Want to clean the steam strainer? There's no need to break the station piping or remove the governor valve in the improved Type D. Does the carbon packing need adjusting? Detachable boxes and garter springs make it easy. All pipe connections are made to the lower half so that the cover can be easily removed for inspection of internal parts.

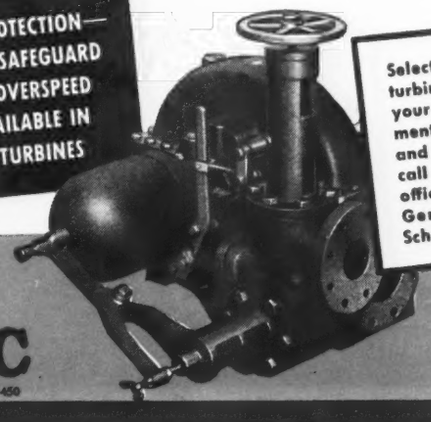
LOW INITIAL COST?

For what you would pay for an ordinary turbine, you can obtain a Type D with positive overspeed protection, improved bearing cooling, and built-in throttle valve. Remember, production line manufacturing, made possible by the widespread demand for this turbine, means more for your turbine dollar.

MINIMUM MAINTENANCE EXPENSE?

It's attention to details that builds reliability—and keeps maintenance costs low—in G-E turbines. Bucket and valve materials are carefully selected for resistance against corrosion and erosion; bearings are water-cooled to give low operating temperatures; packing glands are made of carbon for long life and infrequent attention.

POSITIVE PROTECTION—AN ADDED SAFEGUARD AGAINST OVERSPEED NOW AVAILABLE IN TYPE D TURBINES



Selection of the right turbine depends upon your specific requirements for process steam and power. Why not call our nearest G-E office for practical help? General Electric Co., Schenectady, New York

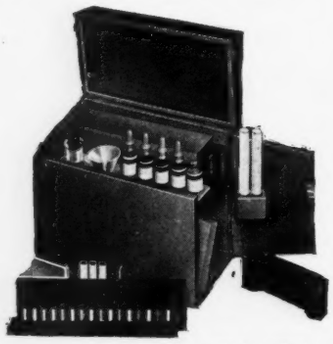
GENERAL ELECTRIC

252-5-450

give your boilers a Break!

. . . and increase their life with

Modern TAYLOR pH and Phosphate Control



Taylor Boiler Water Slide Comparator. Made in two types: Model W for control of both pH and Phosphates; Model P for control of Phosphates only.

Your demands on your steam generating equipment can't afford costly downtime for descaling jobs. Controlling corrosion and scale formation in your boilers is where we'd like to help you.

Taylor pH & Phosphate Control Equipment will help insure longer boiler life and smoother, more economical operation. We offer two types of equipment for phosphate control: the High Phosphate Comparator, having a range of 5 to 100 p.p.m. and the Low Phosphate Comparator, 0 to 25 p.p.m. of phosphate as PO_4. This equipment, molded from plastic, is durable and because it works on the slide principle assures simplicity of operation.

All Taylor Color Standards carry an unlimited guarantee against fading. The reagents used in the phophate sets are extremely stable and can be depended on to give accurate results over a period of several years.

Write for a copy of our new 80 page Handbook "Modern pH and Chlorine Control"—sent FREE for the asking.

W. A. TAYLOR & CO.

7300 YORK ROAD, BALTIMORE, MD.

Specialists in pH Control Equipment

David C Prince, Commercial Engrg Dept, General Electric Co, was elected president. Other officers elected were N S Hibshman, Bethlehem, Pa., J E Houseley, Alcoa, Tenn., Arthur L Jones, Denver, Colo., Walter C Smith, San Francisco, Calif., and C A Price, Hamilton, Ont., vice-presidents; Lester R Gamble, Spokane, Wash., T G LeClair, Chicago, Ill., Fred R Manwell, Jr, Pensacola, Fla., directors; and W I Slichter, New York, N. Y., reelected national treasurer. H H Henline is national secretary.

PUROLATOR PRODUCTS, INC, has announced the following changes in organization: E B Headden has been named executive vice president, S Letzler is advanced to vice president and comptroller, Frank P Herman becomes vice-president in charge of equipment sales, and John M Clarke is appointed vice-president in charge of distributor sales. L W Williams has been named vice-president in charge of engineering, and Jules Kovacs is now chief engineer.

HAWKINS-HAMILTON CO, Richmond, Va., has announced addition of Frank K Howell to organization. Mr Howell, a graduate of Stevens Institute, will be engaged in sales engineering work, handling products of Cochrane Corp, Andale Corp, Hays Corp, Terry Steam Turbine Co, United Conveyor Corp, and others.

D W HAERING & CO, celebrating its tenth anniversary, has transferred general offices to 18th floor of Engineering Bldg at 205 Wacker Drive, Chicago, Ill. Present offices at 2308 S Winchester Ave will be turned over to enlarged technical staff. Mr George E Thompson, formerly of New York office, will be in charge of the Chicago office.

FALK CORP announces appointment of W L Schneider, T F Scannell and J B Kelley as vice president of sales, sales manager and assistant sales manager, respectively. Mr Schneider, while fulfilling his new duties as a vice president, will continue in supervisory capacity of director of sales. Mr Scannell, who succeeds Mr Schneider, will be responsible for active sales of all Falk products, except those under jurisdiction of the Foundry Dept. Mr Kelley in recent years has been in charge of corporation's flexible coupling business.

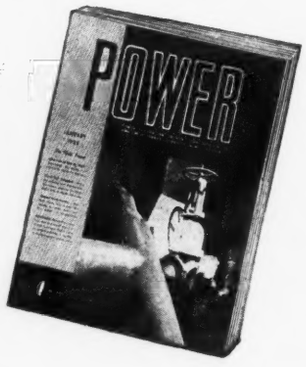
STEEL & TUBES DIV, TIMKEN ROLLER BEARING CO, has appointed Harry McCool, Jr, as southwestern sales representative. His territory includes Kansas, Louisiana, Oklahoma, Arkansas and Texas, with headquarters at Dallas,

NO HOLDS BARRED!

On all moving parts of reciprocating engines, pumps, conveyors, generators, stokers, etc.—use "UNSHAKO." The built-in, self-energizing locking ring is always on guard and springs to life as soon as any backing off tendency asserts itself. It's a relentless grip . . . it's real protection! For details, write

STANDARD PRESSED STEEL CO.

BOX 577, JENKINTOWN, PENNA.



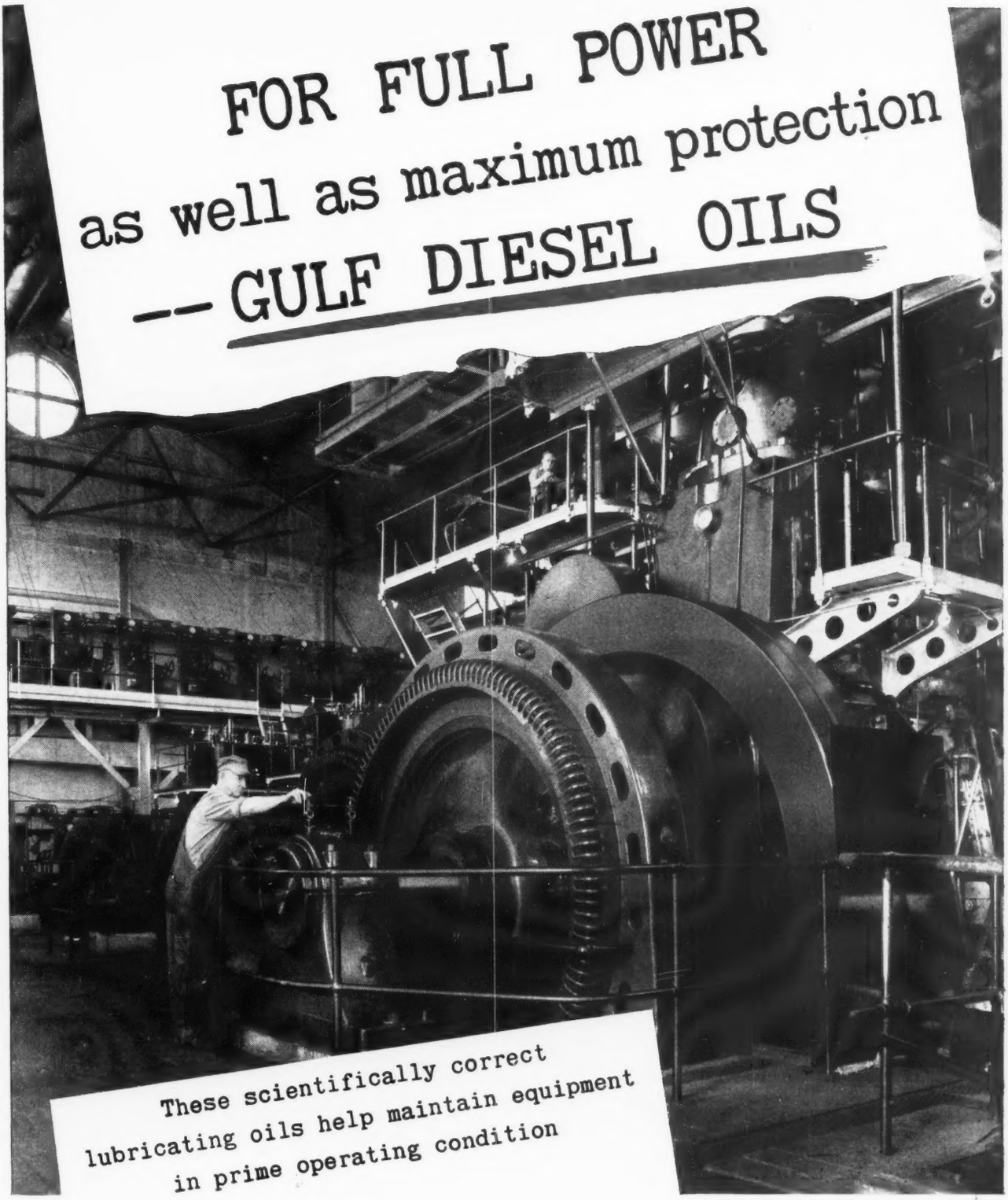
YOUR Dependable Guide

. . . to the big things and little things done each month by operators and manufacturers across the country to raise plant efficiencies, cut costs, and reduce trouble.

It Pays You to

Read POWER Regularly

FOR FULL POWER as well as maximum protection -- GULF DIESEL OILS



These scientifically correct lubricating oils help maintain equipment in prime operating condition

ESPECIALLY manufactured for the lubrication of Diesel engines, Gulf Diesel oils provide maximum protection for cylinders, pistons and bearings—they provide most efficient lubrication and seal against compression losses so that engines can deliver full power.

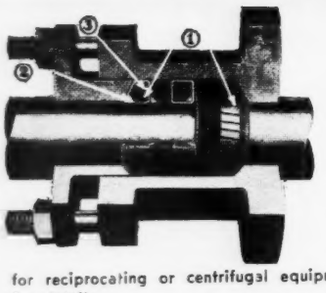
If you have any reason to feel that the operation of *your* Diesels could be improved, ask a Gulf engineer to call—his broad experience with many types of Diesels is your assurance of sound suggestions which will help you get better performance from your units.

The Gulf line of more than 400 quality lubricants is quickly available to you through more than 1200 warehouses located in 30 states from Maine to New Mexico. Write or phone your nearest Gulf office today.

GULF INDUSTRIAL LUBRICATION

GULF OIL CORPORATION · GULF REFINING COMPANY · PITTSBURGH, PA.

There are 3 INDIVIDUAL SEALING ELEMENTS



in SEA-RO ARMORED NEK-SEAL PACKING No. 1505

1. **ARMORED CASING** of anti-friction foil provides full metallic surface that will not score.

2. **NEK-SEAL FILLET** of foil at pressure corner of packing—provides extra sealing and prevents crowding out of stuffing box.

3. **SEMI-METALLIC CORE**—anti-frictional and resilient—assures proper contact with rod or shaft.

Sea-Ro Armored Nek-Seal Packing No. 1505 is recommended for reciprocating or centrifugal equipment, operating against extreme pressures and speeds. Write for details.

SEA-RO PACKING CO., INC., WOOD-RIDGE, N. J. SEA-RO

Visibility

PLUS A PERFECT FIT

WHEN it comes to visibility, you can compare a PYREX Broad Red Line Gauge Glass with any other glass on the market. The results will speak for themselves.

And the accuracy of the gauge glasses you buy has a direct effect on gauge glass maintenance costs. All tubing from which PYREX and CORNING Gauge Glasses are made is machine drawn to uniform accuracy. Thus breakage due to installation strains is reduced to a very minimum.

Add to these important advantages, the relief from danger of breakage caused by sudden temperature shock, resistance to chemical attack and long life, and you have true gauge glass economy. PYREX and CORNING Gauge Glasses are stocked by leading mill and steam supply houses.

"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works

CORNING Glass Works Corning, New York — **Pyrex Gauge Glasses**

Tex. C M Maratta, maintenance engineer for Timken Roller Bearing Co since 1921, has been appointed chief works engineer, filling vacancy caused by death of W C Makley. Walter F Green, who has been with Timken since 1935, becomes assistant works engineer, while Putney L Wright, with Timken since 1938, will be plant engineer.

GREENE, TWEED & Co have moved manufacturing plant and general offices to Palmetto Bldg, at Bronx Blvd and 238th St, near Woodlawn, in New York. New machinery has been installed for manufacturing processes, and to provide for additional lines of packing and other products now being developed.

GRISCOM RUSSELL Co announces new location of its Houston, Texas, office, now at 1548 Esperson Bldg. Company has also moved Tulsa office to new quarters at 810 Petroleum Bldg, Tulsa, Okla.

CONSUMERS POWER Co, main operating unit of Commonwealth & Southern Corp, has announced election of J R Whiting as president. The move comes as part of general movement to comply with terms of the Holding Company Act, relative to the breakup of the corporation's northern properties.

FOXBORO Co, Foxboro, Mass., announces that Paul D Graff has joined its staff as sales engineer, specializing in promotion of company's control instrumentation. He will be located at main office in Foxboro.

WATER TREATMENT CO OF AMERICA, Pittsburgh, Pa., announces appointment of A H Knipe as Cincinnati District sales manager. Mr. Knipe will be located at the company's Cincinnati office, 1331 Inquirer Bldg.

IRON & STEEL PRODUCTS, INC, Chicago, has appointed Paul G Cheatham, Jr, of F I Madero, No. 55, Mexico, D.F., as their representative for Mexico, to succeed P C Morales. Mr Morales has resumed his former position as general superintendent of motive power and machinery of the National Railways of Mexico.

ALUMINATE CHEMICALS, LTD, representatives of National Aluminate Corp in Canada, has moved from 372 Bay St to 555 Eastern Ave, Toronto, Ontario.

At a recent meeting of Keystone Association No. 16, NATIONAL ASSOCIATION OF POWER ENGINEERS, in Buffalo, N. Y., George M Diebold was installed as president. Other officers installed were George Grupp, vice president; Lenhard W Thiele, corresponding secretary; T Joseph Hogan, recording secre-

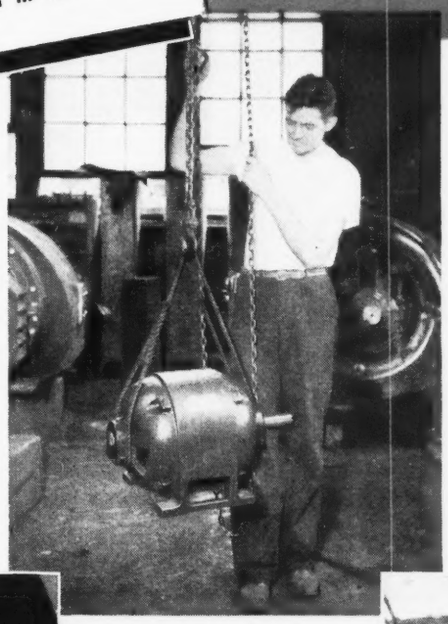
SEE HOW YOU SAVE TIME

WITH THE TRI-CLAD MOTOR

REG. U. S. PAT. OFF

Extra Convenience Features

help you get the Tri-Clad motor into service faster—keep it in service with less attention.



1. Easy to Handle

They can be moved into position easily because of their light weight and compactness. The shape of the bearing housings and the location of end-shield fittings make it easy to handle Tri-Clad motors with slings. In addition, they are sturdily built and do not have to be coddled.

2. Quickly Mounted or Altered

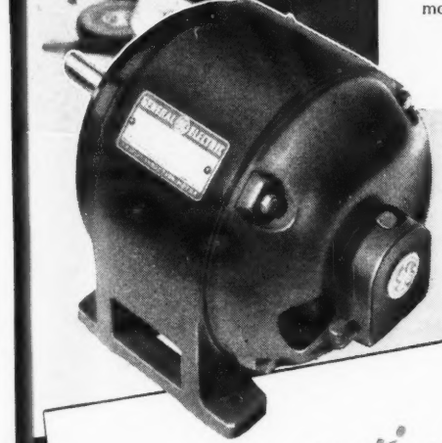
Their feet are machined accurately and drilled for standard mounting bolts. The reversible stator puts the roomy conduit box on the most convenient side and the end-shields can be rotated to any of four positions to meet mounting requirements.

3. Easy to Wire

A large, four-position conduit box gives unrestricted working space. It can be quickly removed for wiring. Flexible leads are pressed on the terminals which are permanently identified. No soldered connections are necessary. A stainless-steel, graphic connection plate is conveniently located on the conduit-box side of the motor.

4. Convenient to Lubricate

All Tri-Clad motors have a large oil or grease capacity. On sleeve-bearing motors, the oil-filler gage can be located on either side of the bearing housing. A spring cover on this gage permits quick checking of the oil level. On ball-bearing motors, a pressure-relief greasing system assures rapid and thorough greasing.



BUILT FOR PROTECTION FIRST . . . TO LAST

Extra Protection 3 Ways

HELPS ASSURE LONG SERVICE LIFE

Production interruptions are avoided and operating time is saved when the motor you buy can stand up under the many adverse operating conditions commonly found in industry. Tri-Clad motors meet these conditions with—

1. *Extra Protection* against physical damage
2. *Extra Protection* against electrical breakdown
3. *Extra Protection* against operating wear

The new General Electric Tri-Clad motor is a cinch to install. Its convenience features pay off in precious minutes saved—both for those who build motors into machines and for those who use them in a plant.

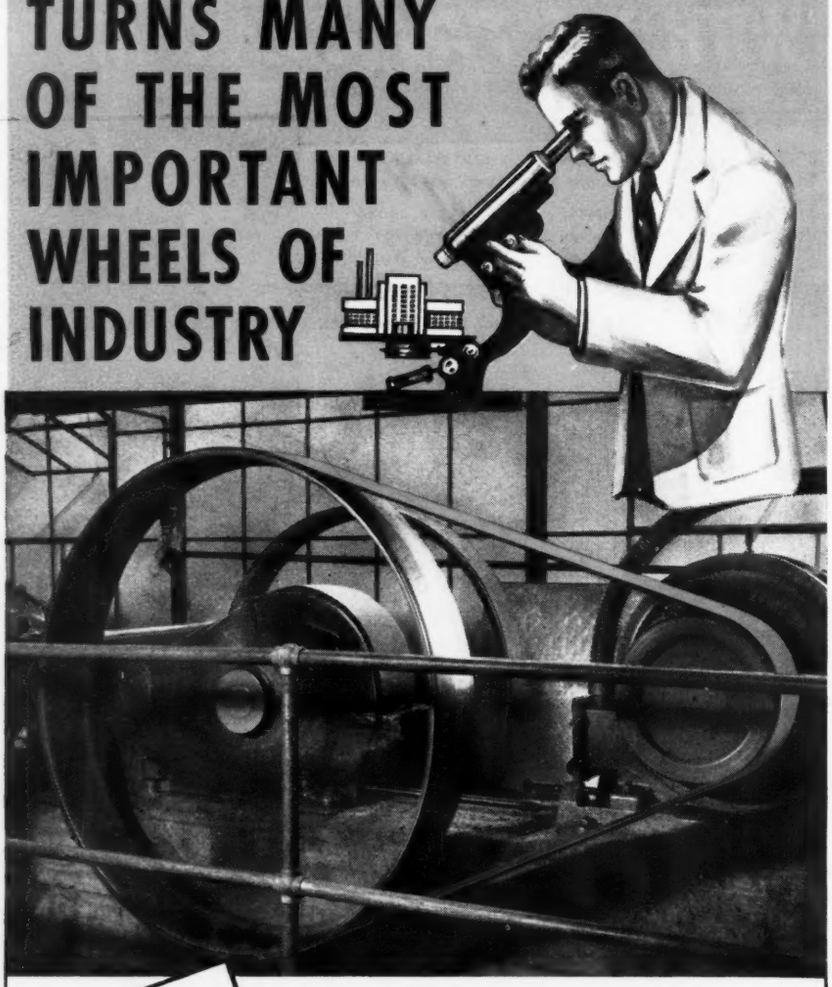
Next time you order motors, take *time-saving* into account, along with protection and performance; make sure you get Tri-Clad motors—now available in a wide range of types and integral horsepower sizes to 20 hp.

Write for Bulletin GEA-3580 which gives full details about these extra protection features and other Tri-Clad motor advantages.

GENERAL ELECTRIC

750-81-8058

TANNATE LEATHER BELTING TURNS MANY OF THE MOST IMPORTANT WHEELS OF INDUSTRY



FOR INSTANCE.. Many vital products are made on machines driven with TANNATE Leather Belts such as: Chemicals, Compressed Gases, Metal Working, Paper & Pulp, Textile.

HERE'S WHAT YOU GET WITH TANNATE • GREATER PRODUCTION from maximum speeds even at peak loads! TIGHTER GRIP that transmits more power! LOWER COSTS in operation and in maintenance because it saves power—is longer lived! HIGHER QUALITY OF MACHINE OUTPUT through steady flow of power under varying conditions of load! These are Tannate performances in industrial plants of all types.

* You, too, can benefit by TANNATE performance. Ask us for specific recommendations on your drives.

STEP UP PRODUCTION with RHOADS Tannate WATERSHED LEATHER BELTING

Established 1702

J. E. RHOADS & SONS • 35 N. 6th ST., PHILADELPHIA, PA.

NEW YORK • CHICAGO • ATLANTA • CLEVELAND

tary; William L Buchs, financial secretary; Herbert H Thielke, treasurer; Joseph C Tryon, past president; Thomas E McKee, conductor, and Joseph Brocklehurst, doorkeeper.

Order Bonneville Generators

An order has been placed with the General Electric Co for the last four of ten generators which will complete the 576,000-kva hydroelectric power development at Bonneville.

The units will be rated at 60,000 kva, and are expected to be installed by the end of 1943. Four generators are already in operation at Bonneville, and two others are being put in at the station. All are rated 60,000 kva, except the first two units, which are 48,000 kva.

Manchester Adds Unit

A 10,000-kw G E steam-turbine unit, together with a B & W integral-furnace boiler and Westinghouse condenser will be installed at the Manchester station of the Public Service Co of New Hampshire. The addition is expected to be completed by July 1942, and will increase the plant capacity to 30,000 kw. The new boiler capacity will be 125,000 lb of steam per hour, and pressure at superheater outlet will be 625 lb, 750 F. Either fuel oil or coal can be burned. This addition to the steam-generating facilities of the company supplements other plants used in peak-load operation and the floating power plant "Jacona".

R C Farrington Dies

Robert C Farrington, 59, chief mechanical engineer of the Austin Co, since 1919, died at St. Joseph's Hospital, Fort Worth, Texas, July 15, following a heart attack. He was a graduate of Syracuse University in 1903 and for the following two years was employed as engineer and estimator with W N Tobin in New York. From 1906 to 1913 Mr Farrington was engaged in professional engineering work. In 1913 he became president and general manager of the York Engineering Co at York, Pa., and continued in that capacity until he joined the Austin organization. He supervised the control facilities for the first windowless factory, which Austin designed and built for Simonds Saw & Steel Co, at Fitchburg, Mass., in 1931.